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Multi-Transducer Dummy Unit Evaluation of Polystyrene Bead Foam as an Encapsulant for Electronic Packages

By G. D. Swanson

Published September 1980

Topical Report
D. J. Fossey, Project Leader

Prepared for the United States Department of Energy
Under Contract Number DE-AC04-76-DP00613.

Bendix Kansas City Division

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MULTI-TRANSDUCER DUMMY UNIT EVALUATION OF POLYSYTRENE BEAD FOAM AS AN ENCAPSULANT FOR ELECTRONIC PACKAGES

By G. D. Swanson

Published September 1980

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MULTI-TRANSDUCER DUMMY UNIT EVALUATION OF POLYSYTRENE BEAD FOAM AS AN ENCAPSULANT FOR ELECTRONIC PACKAGES

BDX-613-2488, Topical Report, Published September 1980

Prepared by G. D. Swanson

A dummy electronic assembly without electronic components was used to measure loadings and deflections caused by 0.2, 0.3, 0.4, 0.5 and 0.6 g/cm^3 densities of polystyrene bead foam during fusion and thermal cycling. Previously developed and proven transducers showed that the lower three densities caused low and safe loads and deflections, but that the highest two densities must be used with care for fragile electronic components.

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Kansas City, Missouri 64141

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SUMMARY

Polystyrene bead foam (PSBF) is a candidate encapsulant material for electronic packages. Hence, the types and magnitudes of thermally-generated mechanical loadings on electronic components are not known. In addition, previous encapsulant materials have generally bonded well to most materials, while PSBF has not. The work reported here uses a dummy electronic assembly without electronic components to measure loadings and deflections caused by 0.2, 0.3, 0.4, 0.5 and 0.6 g/cm^3 densities of PSBF during fusion and thermal cycling.

A variety of proven strain-gage transducers were used to measure loads and deflections. The quantities measured were the deflection of printed wiring boards (PWBs) normal to their plane, localized strain in the plane of PWBs, lateral force parallel to the surface of a PWB, lateral deflection parallel to the surface of a PWB, and the thermomechanical pressure on a strain-gaged transistor. These quantities were judged to have the highest potential for damaging electronic components in packages encapsulated in PSBF. PSBF of low densities is flexible enough to eliminate the need for conformal coatings to protect electronic components required by more rigid encapsulants. Nearly equally low loadings and deflections were measured for 0.2 and 0.3 g/cm^3 PSBF; values for 0.4 g/cm^3 were intermediate; and densities of 0.5 and 0.6 g/cm^3 produced nearly equally high loadings and deflections.

Robust electronic components such as inductors should be safe in all densities, but care must be used when encapsulating fragile electronic components like ceramic microcircuits in the highest two densities, where fairly large crushing pressures can develop.

If PWBs are not rigidly fixed in place by support posts or fixtures, significant movement can occur during the fusion cycle. Therefore, all electronic components must be adequately protected from electrical shorting or from change in critical circuit parameters which may result from such movement. After fusion, essentially no PWB movement occurs.

DISCUSSION

SCOPE AND PURPOSE

The work reported here is part of an effort to evaluate polysytrene bead foam (PSBF) as an encapsulant for electronic packages. Experimental data were needed to characterize the various properties of PSBF with densities from 0.1 to 0.6 g/cm^3. The data are needed to recommend the correct foam density, appropriate bead fusion conditions, and other critical encapsulation process requirements necessary to guarantee adequate environmental protection for future electronic packages which use PSBF as the encapsulant.

All encapsulated electronic packages must withstand the thermomechanically-caused loads and deflections which act on the individual electronic components. Using proven transducers, these loads and deflections were measured. The test vehicle chosen was a dummy electronic package, the production version of which is a candidate for PSBF encapsulation.

PRIOR WORK

Physical, mechanical, and chemical properties of structural PSBF have been reported.[1] Thermomechanical interactions when encapsulating a quite different electronic package in 0.2 g/cm^3 PSBF also have been reported.[2] Thumb-tack generalized models of electronic components have compared loadings on solder joints caused by five densities of PSBF encapsulation. Also measured was moisture penetration for five densities and several different fusion cycles of PSBF. Mechanical properties of potting PSBF of five densities are available. No other work is known which attempts to measure thermomechanically-caused loads and deflections for electronic packages encapsulated in a range of densities of PSBF.

ACTIVITY

The test vehicle chosen to measure loads and deflections was a dummy electronic package with printed wiring boards (PWBs) installed, but without electronic components. Transducers which had been developed and proven in earlier work were mounted on the PWBs to simulate electronic components. Data from these transducers were to be analyzed to predict the severest loading mechanisms and their magnitudes. Appropriate transducers and locations then could be chosen for later tests on a production equivalent electronic package.

Experimentation

Five types of proven transducers[2] were placed in the dummy unit to measure these five quantities:

1. Deflection of PWBs normal to their plane,

2. Localized strain in the plane of PWBs,

3. Lateral force parallel to the surface of a PWB,

4. Lateral deflection parallel to the surface of a PWB, and

5. The resulting thermomechanical pressure on a strain-gaged transistor.

These proven transducer types were deemed adequate to survey the types of loads and deflections expected from encapsulating the dummy unit in PSBF and from later thermal cycling.

Figures 1 and 2 show the dummy unit and the transducer locations. Figure 1 is an end view with the cover removed. It shows the lateral force transducer (F), the lateral deflection transducer (D), and the four PWB deflection transducers (B_1, B_2, B_3 and B_4). B_1 is attached to the full-height PWB closest to the case, and B_4 is attached to the fourth full-height PWB. This relation is shown better in the oblique view of Figure 2 which has the cylindrical case removed. Here R is one of a matched pair of right-angle strain gages on the PWB. Another right-angle pair is on the opposite side of the PWB at the same location. A second set of right-angle strain gages is mounted at the center of the circular PWB nearest the bottom plate. The strain-gaged transistor which acts as a pressure transducer is mounted from the bottom of the same PWB.

After all the transducers were manufactured, instrumented, mounted, calibrated, and thermal compensated, the unit was filled with 0.2 g/cm^3 pre-expanded polystyrene beads and the top cover was clamped in place. The beads then were fused together into PSBF by being heated for 20 minutes after the center of the unit reached 93°C in an oven set at 102°C. Three thermal cycles were monitored and the unit was then depotted in air-agitated toluene; the transducers were rechecked; and the sequence was repeated for the next highest density. More than three thermal cycles were performed for higher density PSBF in order to follow progressive changes from cycle to cycle.

Table 1 lists some specifics of the fusion and thermal cycles. All fusion was done in an oven preheated to 102°C. Table 1 shows the total time in the oven and the maximum temperature measured by any thermocouple inside the unit. The table also lists the

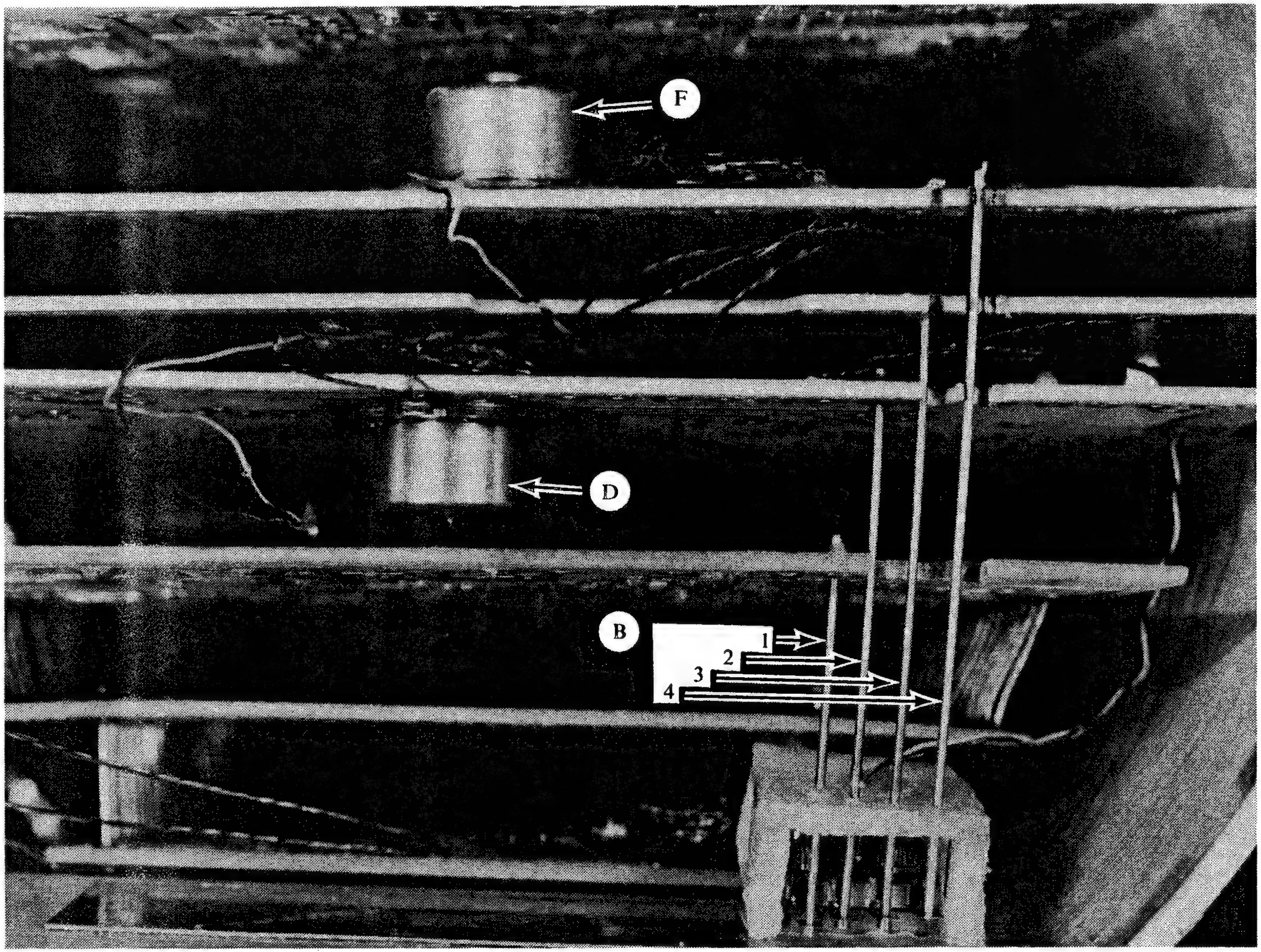

Figure 1. End View of Dummy Unit Showing Transducer Locations

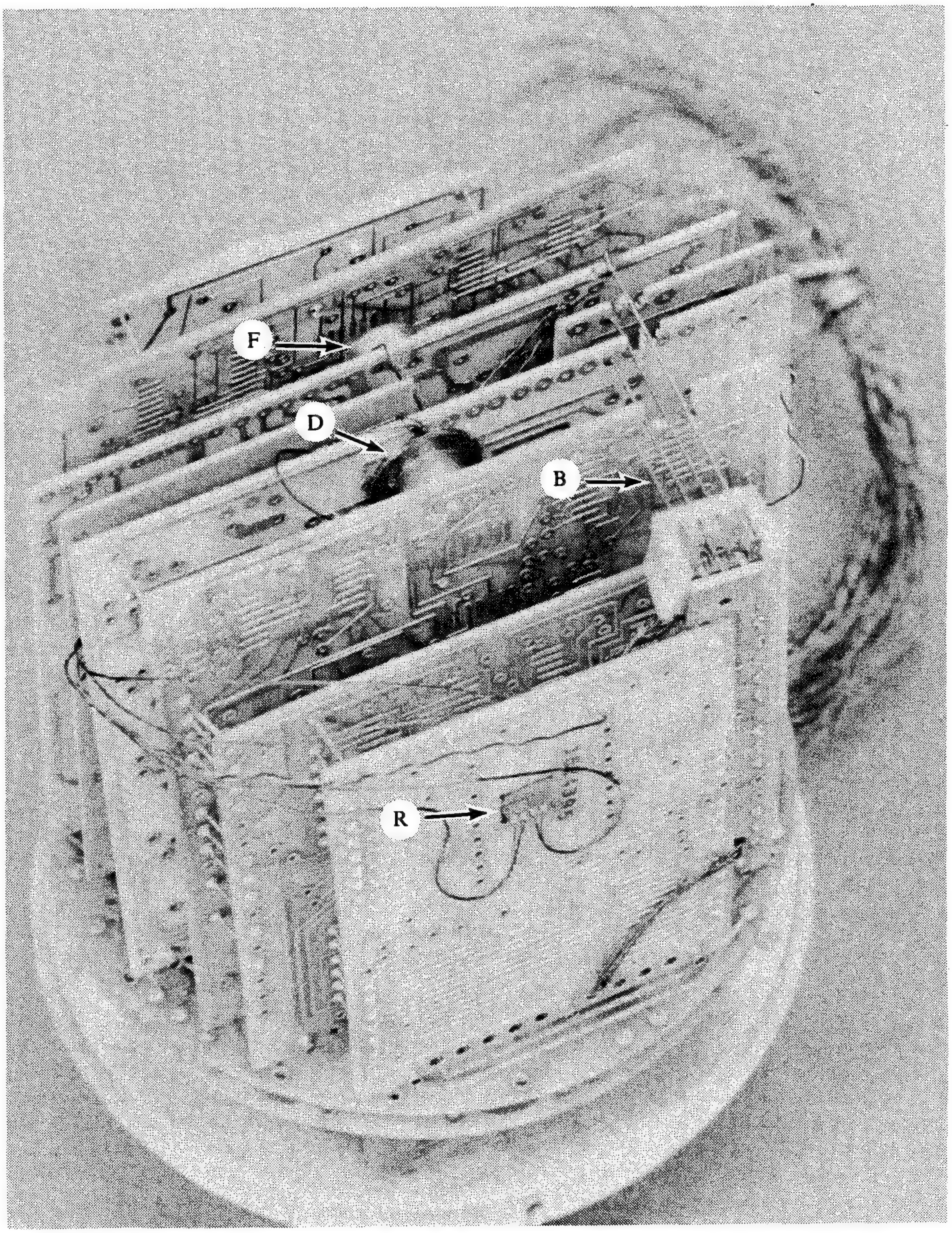

Figure 2. Oblique View of Dummy Unit With the Cover Removed

Table 1. Time and Temperature Data for Fusion and Thermal Cycles for Dummy Unit

	Fusion Cycles*		Thermal Cycles			
					Temperature (°C)	
PSBF Density (g/cm^3)	Time In Oven (Minutes)	Maximum Temperature (°C)	Number	Time** (Minutes)	Minimum	Maximum
0.2	92	100	1	305	-58	76
			2	325	-56	78
			3	340	-57	77
0.3	99	101	1	375	-56	78
			2	339	-57	76
			3	330	-56	76
0.4	110	100	1	390	-57	77
			2	390	-58	77
			3	366	-57	78
			4	366	-57	78
0.5	110	100	1	375	-60	77
			2	372	-57	78
			3	380	-57	77
			4	350	-58	78
0.6	107	103	1	375	-59	78
			2	355	-60	78
			3	363	-58	76
			4	360	-60	76

Table 1 Continued. Time and Temperature Data for Fusion and Thermal Cycles for Dummy Unit

	Fusion Cycles*		Thermal Cycles			
					Temperature (°C)	
PSBF Density (g/cm^3)	Time In Oven (Minutes)	Maximum Temperature (°C)	Number	Time** (Minutes)	Minimum	Maximum
			5	420	-57	77
			6	322	-58	77
			7	325	-55	76

*Nominal cure for all densities was 20 minutes after center of unit reached 93°C

**Total duration of data record for this cycle

minimum and maximum temperatures for each thermal cycle, and the total duration of that data record. The thermal cycle times from the start at ambient until the finish at ambient vary for a given density because the temperature was manually controlled.

Test Results

A large amount of experimental data was accumulated for the several tests described in Table 1 for each of the transducers shown in Figures 1 and 2. A total of 260 graphs were prepared from the computer-reduced data. Some trends were established as direct results of density change and successive thermal cycles. However, in many cases, no significant change occurred with successive thermal cycles; hence, the much smaller number of data plots exhibited here shows all important aspects of the total data set.

Figure 3 shows the movement of the free ends of the PWBs relative to the case, as measured by B_1, B_2, B_3, and B_4 during the 0.2 g/cm^3 PSBF fusion. As the filled unit heats to the fusion temperature, the PWBs move and adjust to equilibrate the forces acting on the two faces. PWBs 1 and 2 move toward the case and PWBs 3 and 4 move away from the case. The PWBs then retrace that motion and finally reach an equilibrium after the individual beads are fused into a solid foam, such that PWB 1 is essentially at its original position and the other three are slightly further from the case.

During the three thermal cycles, only a very slight movement away from the case occurred at low temperature for each cycle. Upon heating back to room temperature, each PWB moved back to its position after fusion. This behavior was nearly identical for each successive cycle. The movement at low temperature is caused by PSBF thermally contracting faster than the case and by the lack of bonding of the PSBF to the case.

Figure 4 shows the PWB movement during fusion of 0.3 g/cm^3 PSBF. The transients are larger as the PWBs move to equilibrate forces. Again, a very slight cyclical movement occurred for the thermal cycles, with no significant change from cycle to cycle.

During depotting of the 0.3 g/cm^3 PSBF, board deflectometers B_1 and B_4 were damaged. Since the delay necessary to repair them was unacceptably long, the other tests were done with no B_1 or B_4 data. B_2 continued to collect data for all PSBF densities and showed only one small transient for 0.6 g/cm^3 density (less than that seen for B_3 for fusion of 0.2 g/cm^3). B_3 collected data for 0.4 and 0.5 g/cm^3 densities with only slightly larger negative excursions than seen in Figure 4 for 0.3 g/cm^3. Only very small cyclical changes in deflection occurred during the thermal cycles, with almost no change from cycle to cycle, so those data are not shown here.

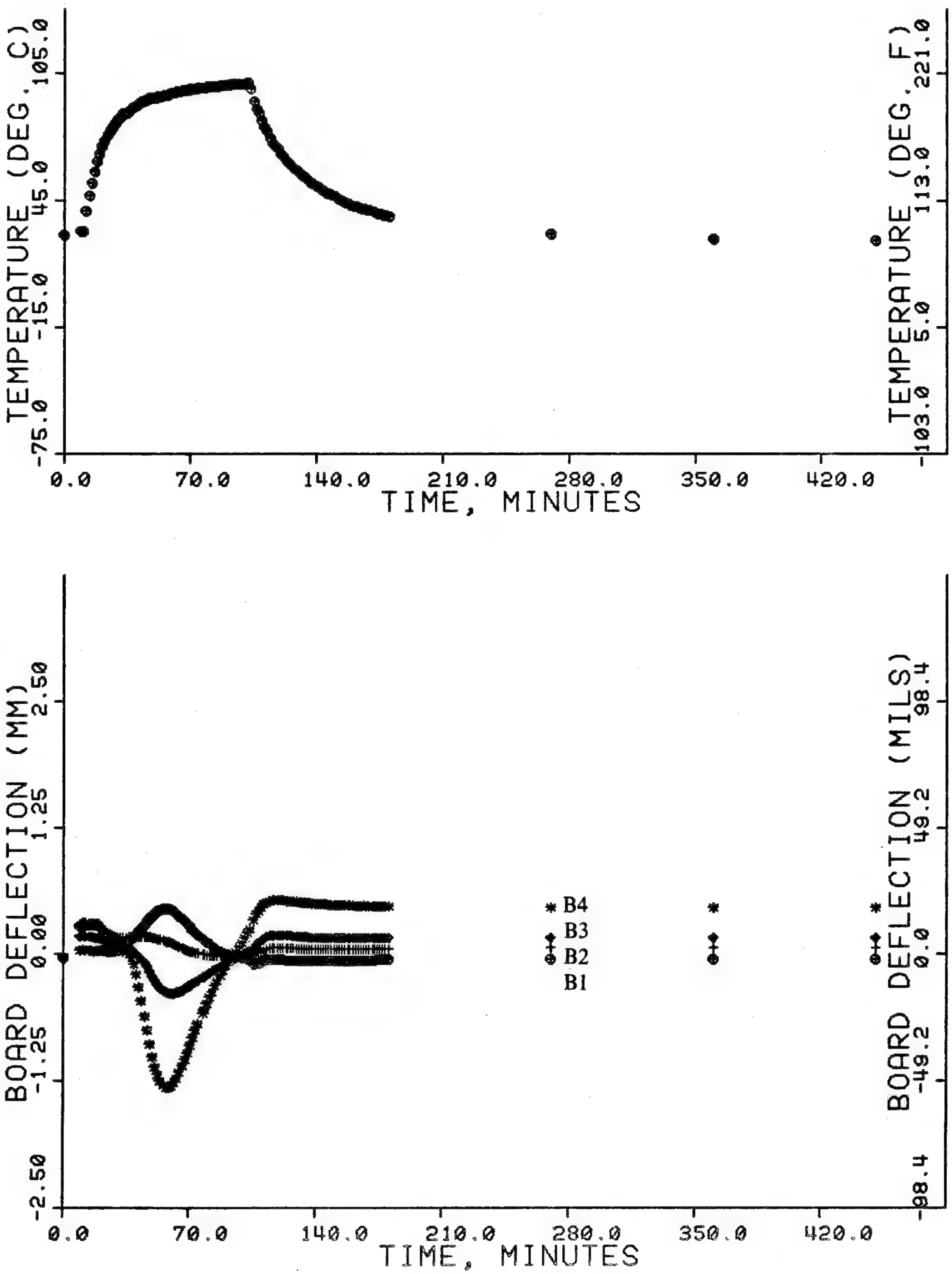

Figure 3. PWB Deflection During 0.2 g/cm^3 PSBF Fusion

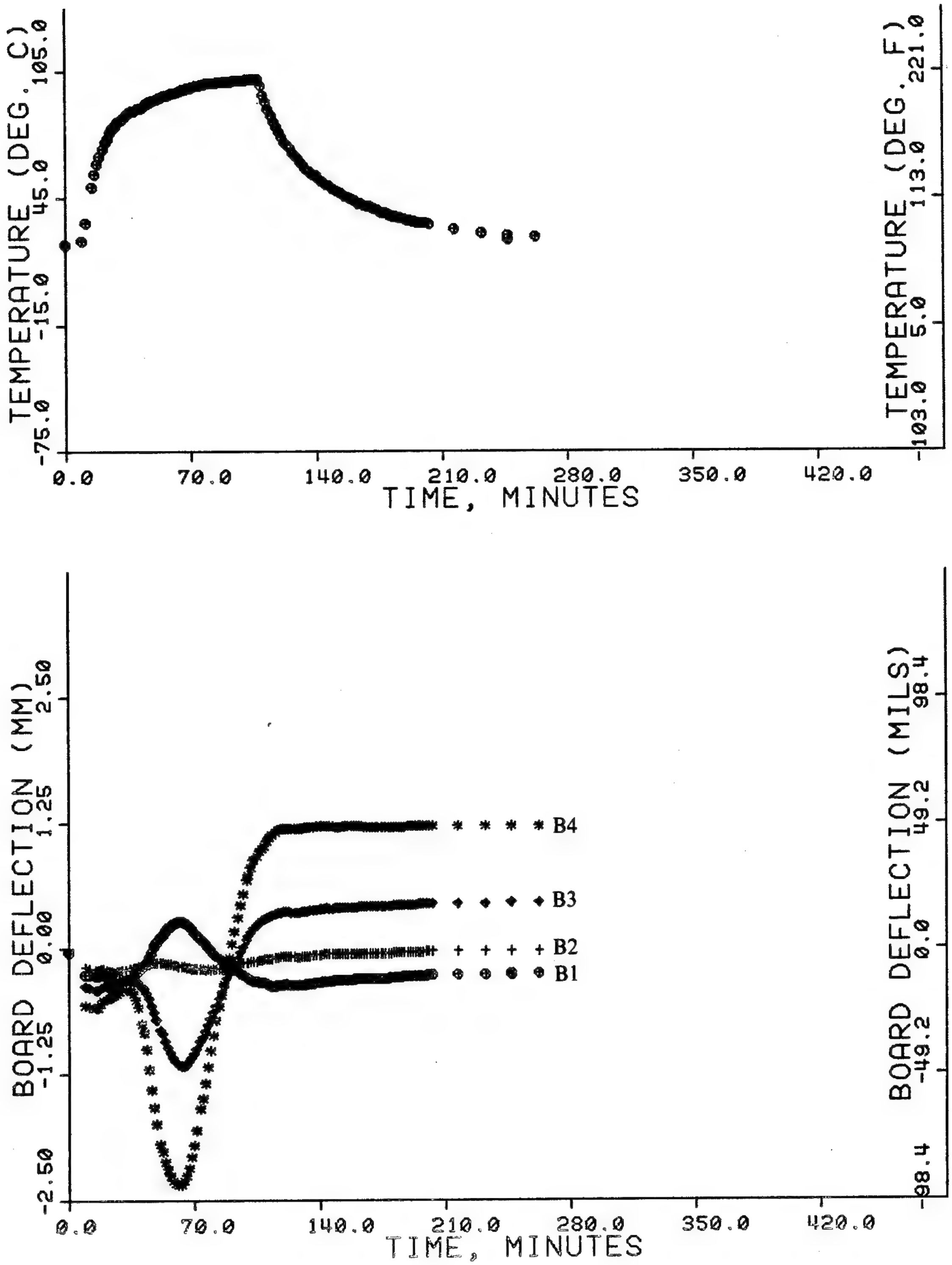

Figure 4. PWB Deflection During 0.3 g/cm^3 PSBF Fusion

The set of right-angle strain gage rosettes (R) at the center of the bottom circular PWB and oriented normal to the vertical PWBs (Strain 1 on Figures 5 through 8) moved only slightly during the several fusion cycles. Figures 5 and 6 show the results for 0.2 g/cm^3 and 0.6 g/cm^3 PSBF fusion cycles, respectively. The data curves are separated enough in Figure 6 to show the individual data for top and bottom strain gages and also the reduction into tension and bending components. The bending component was nearly zero for the entire fusion cycle. Figure 7 shows only small strain changes during thermal cycling of 0.2 g/cm^3 PSBF, but Figure 8 shows very significant strains for 0.6 g/cm^3 PSBF. These strains are almost totally compression with very little bending component. Only a small strain relaxation occurred with successive thermal cycles of 0.5 and 0.6 g/cm^3 PSBF. Behavior of these two high densities was nearly identical.

The other pair of strain gages on the bottom circular PWB was immediately adjacent to and oriented at right angles to the pair just discussed. Thus, the gage elements were parallel to the vertical PWB (Strain 2 on Figures 9 through 12). Almost no strain occurred for 0.2 and 0.3 g/cm^3 PSBF fusion or thermal cycles. Figures 9 and 10 show the response during the 0.4 and 0.6 g/cm^3 fusion cycles. Figures 11 and 12 show the strain during the first thermal cycle of 0.4 and 0.6 g/cm^3, respectively. With succeeding thermal cycles, only a slight relaxation to smaller strain values and only a small amount of PWB bending strain occurred.

The other PWB strains were measured at R on Figure 2. Strain 3 is across the PWB and Strain 4 is along the length of the PWB. These strains are generally larger than Strains 1 and 2 on the bottom circular PWB. And even though some transient bending strain occurred during the fusion heat-up, almost no bending strain was seen during the thermal cycles.

Strains were very low for 0.2 and 0.3 g/cm^3 fusion and thermal cycles and will not be shown here. Figures 13 and 14 show Strain 3 for 0.4 and 0.6 g/cm^3 fusion. Figure 15 shows Strain 3 during 0.4 g/cm^3 thermal cycle 1. Figures 16 and 17 show Strain 3 during 0.6 g/cm^3 thermal cycles 1 and 7. A significant strain relaxation occurred during the thermal cycles. Data for 0.5 g/cm^3 were very similar to those for 0.6 g/cm^3. Data for Strain 4 were very similar to those for Strain 3. Little strain resulted in 0.2 and 0.3 g/cm^3 fusion on thermal cycles. Figures 18 and 19 show Strain 4 during 0.4 and 0.6 g/cm^3 fusion, Figure 20 for 0.4 g/cm^3 thermal cycle 1, and Figures 21 and 22 for 0.6 g/cm^3 thermal cycles 1 and 7. Again, 0.5 g/cm^3 behavior was very similar to that of 0.6 g/cm^3. Also, most of the relaxation takes place between thermal cycles 1 and 2, but a slight additional relaxation was still occurring when cycling was stopped.

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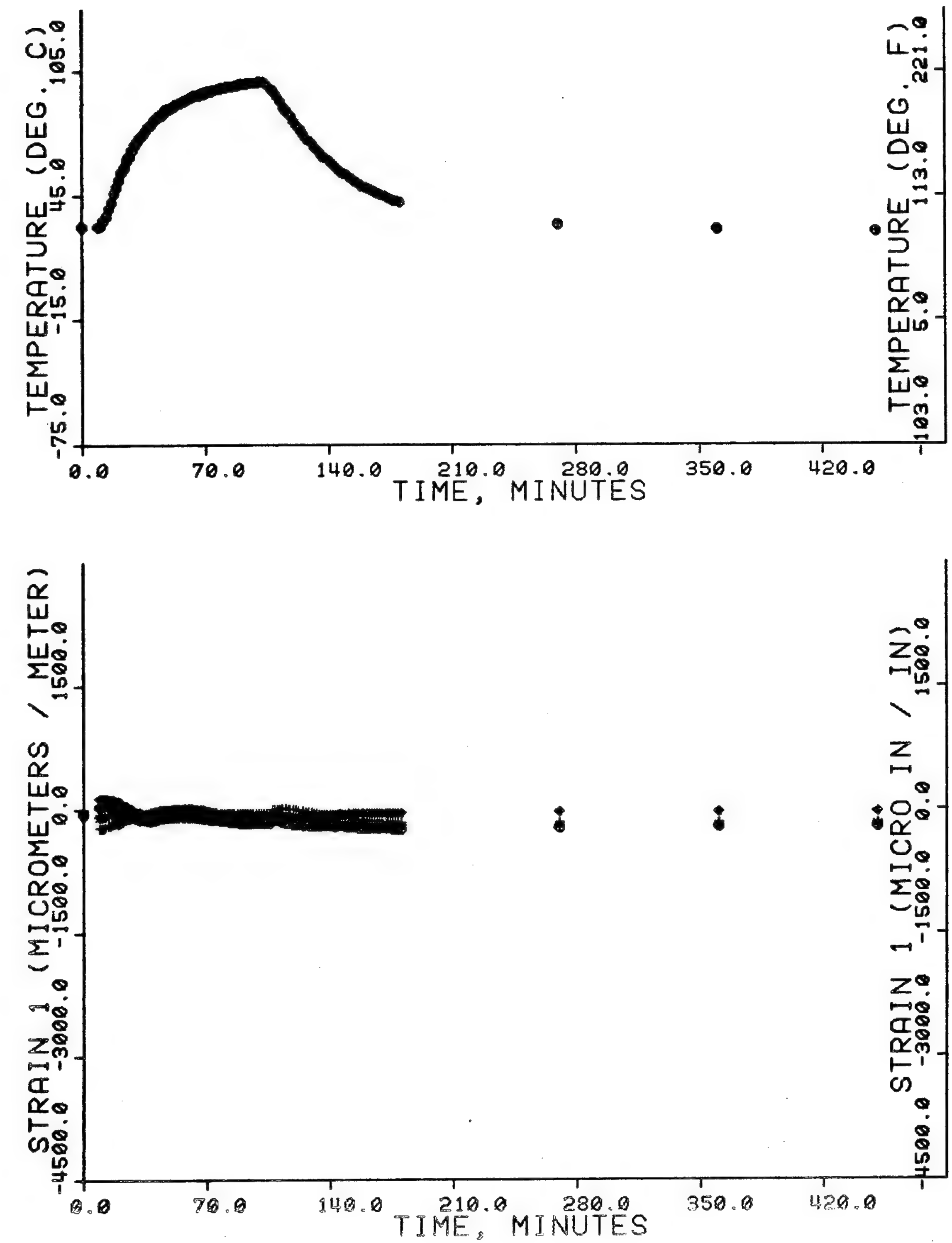


Figure 5. Response of Strain Gage Pair 1 on Bottom PWB During 0.2 g/cm^3 PSBF Fusion

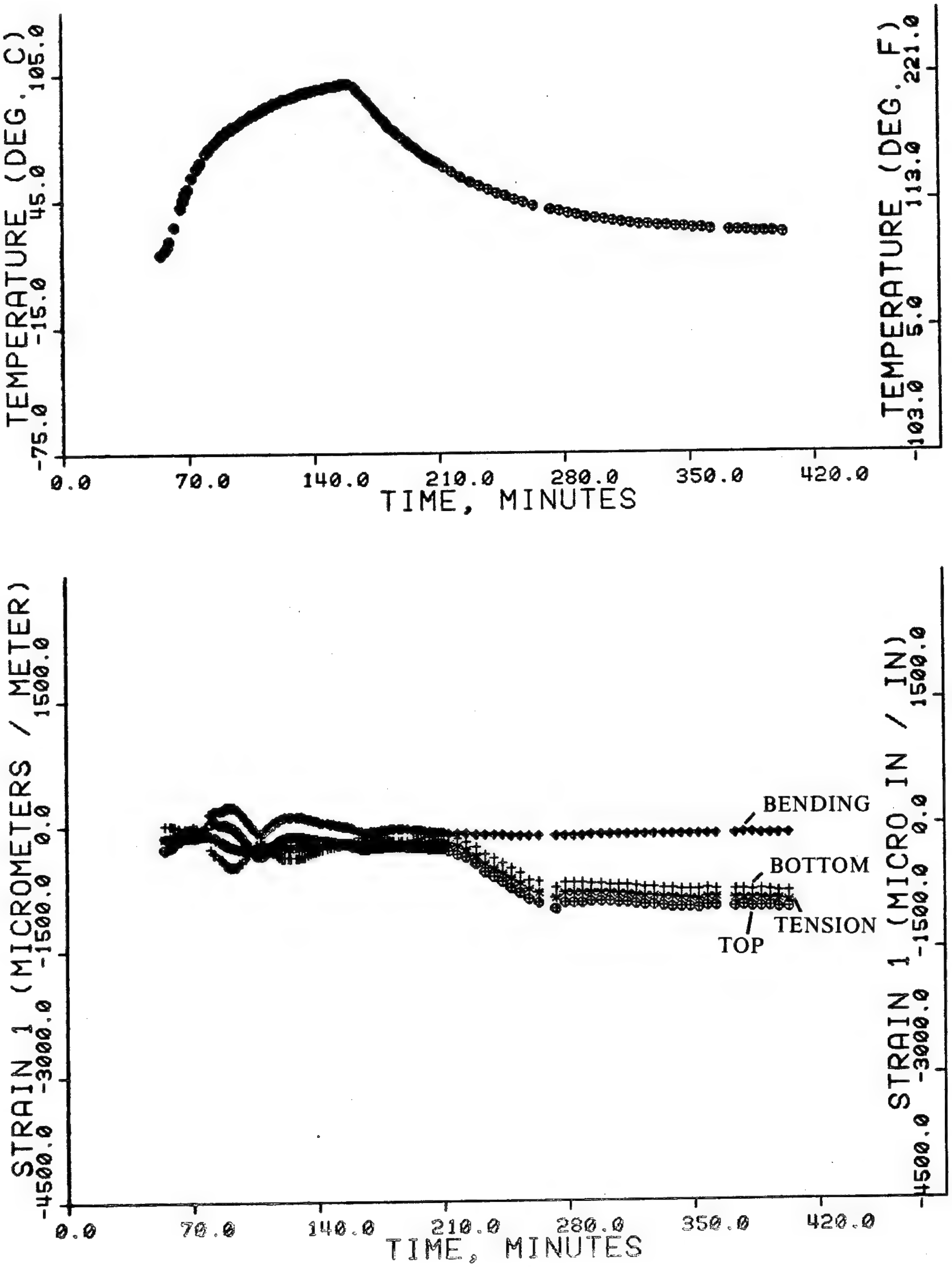
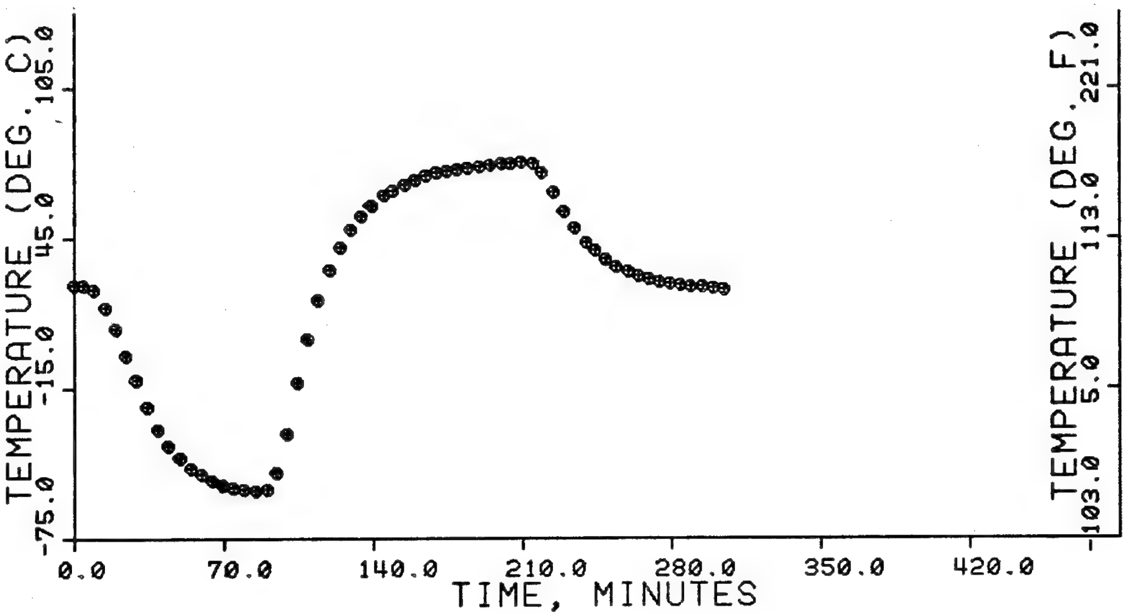


Figure 6. Response of Strain Gage Pair 1 on Bottom PWB During 0.6 g/cm³ PSBF Fusion



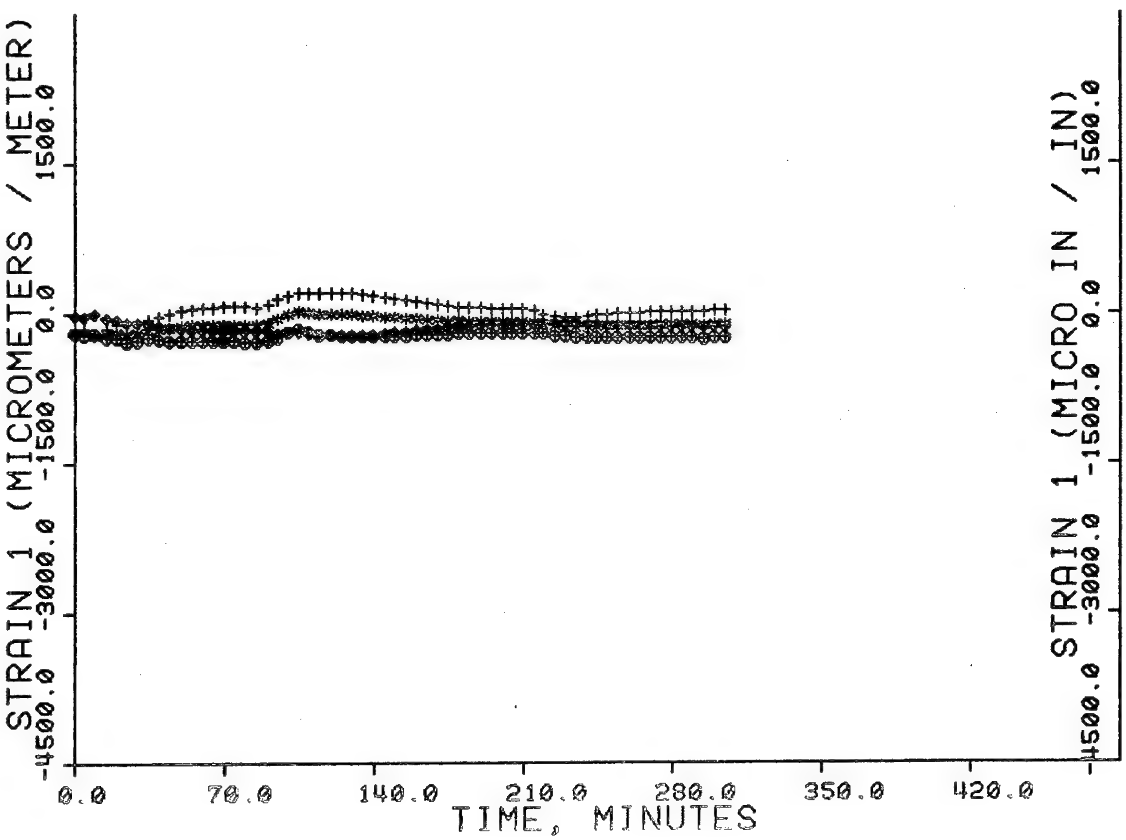


Figure 7. Response of Strain Gage Pair 1 on Bottom PWB During 0.2 g/cm^3 PSBF Thermal Cycle 1

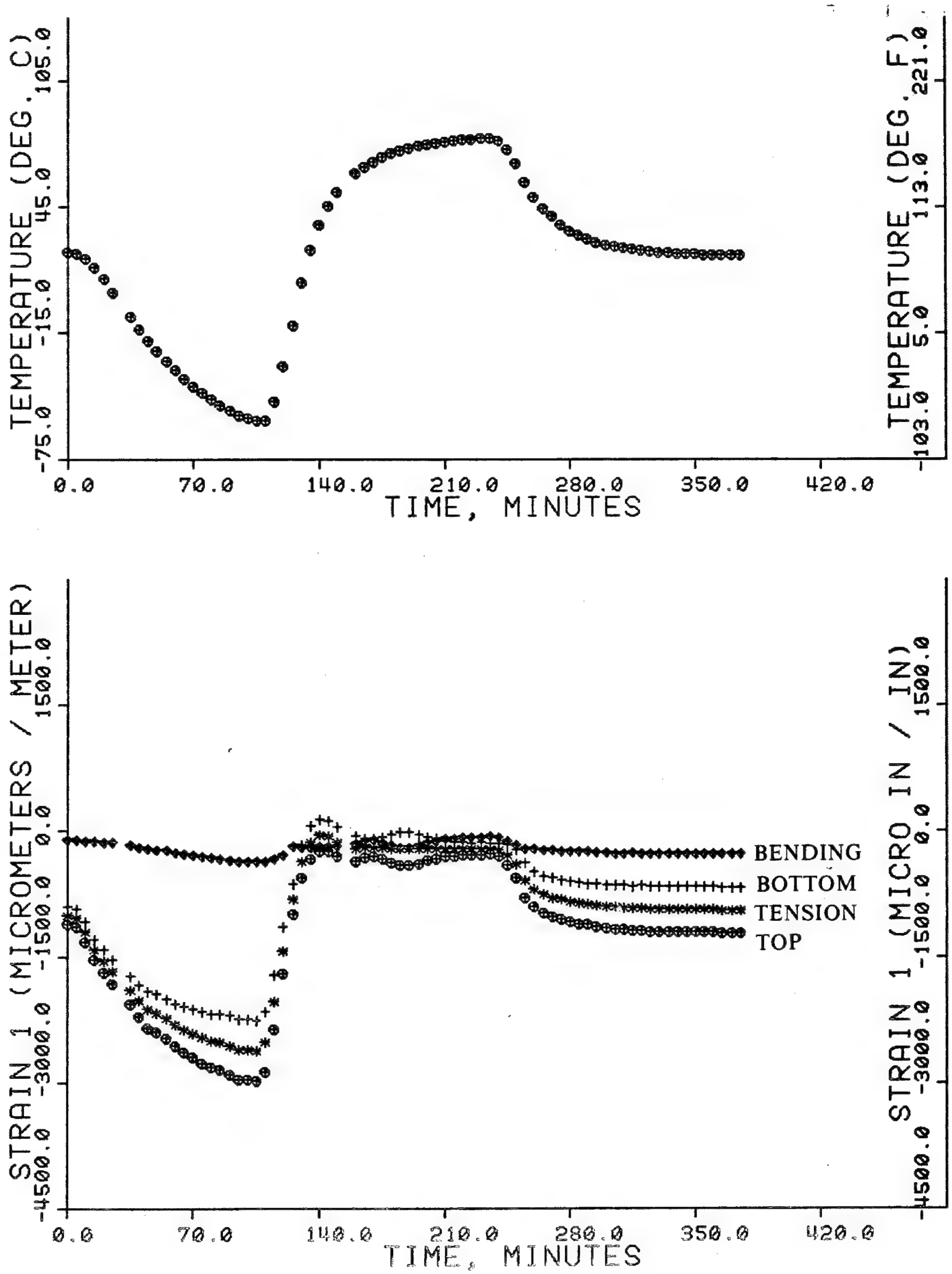


Figure 8. Response of Strain Gage Pair 1 on Bottom PWB During 0.6 g/cm^3 PSBF Thermal Cycle 1

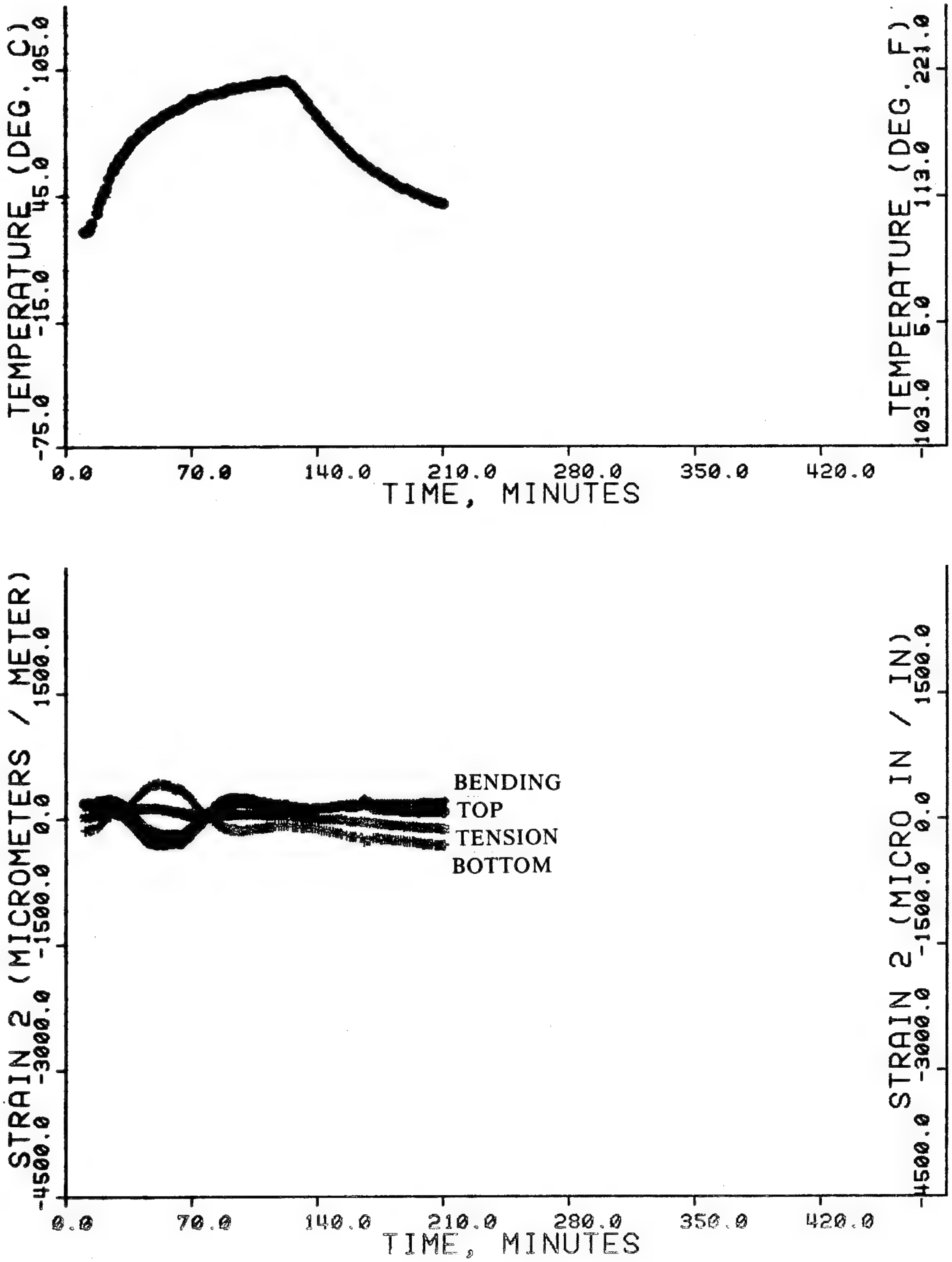


Figure 9. Response of Strain Gage Pair 2 on Bottom PWB During 0.4 g/cm³ PSBF Fusion

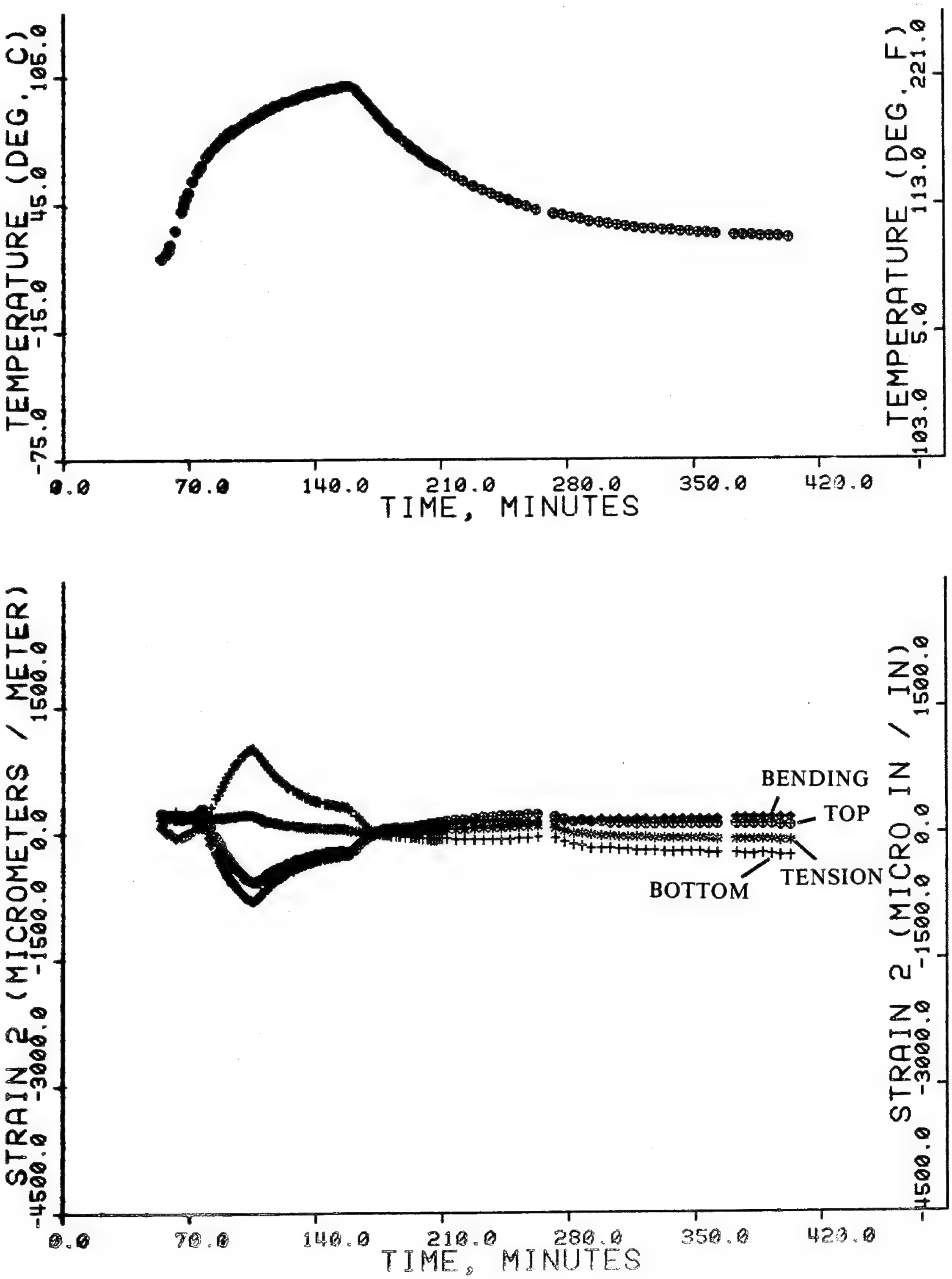


Figure 10. Response of Strain Gage Pair 2 on Bottom PWB During 0.6 g/cm³ PSBF Fusion

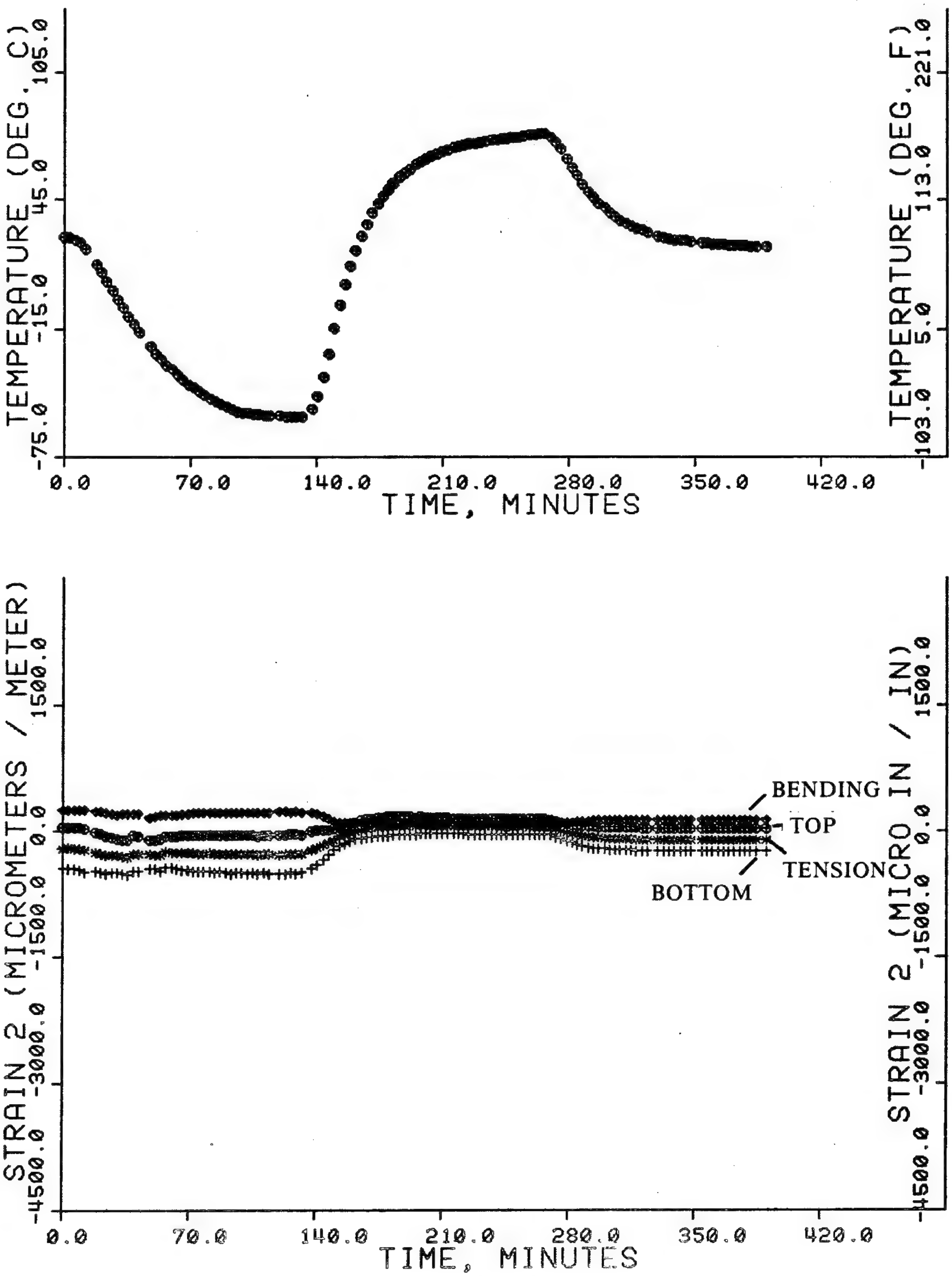


Figure 11. Response of Strain Gage Pair 2 on Bottom PWB During 0.4 g/cm^3 PSBF Thermal Cycle 1

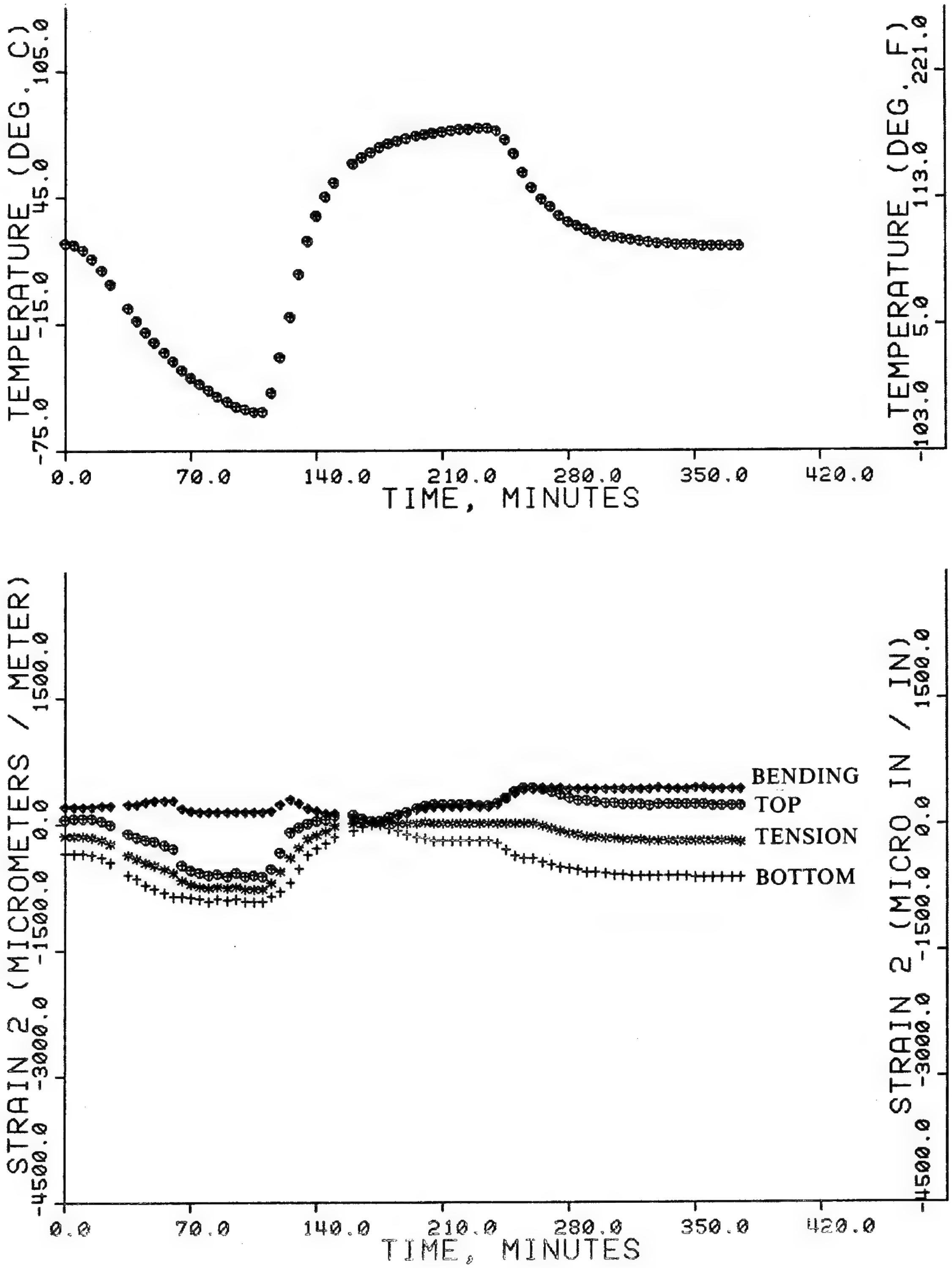
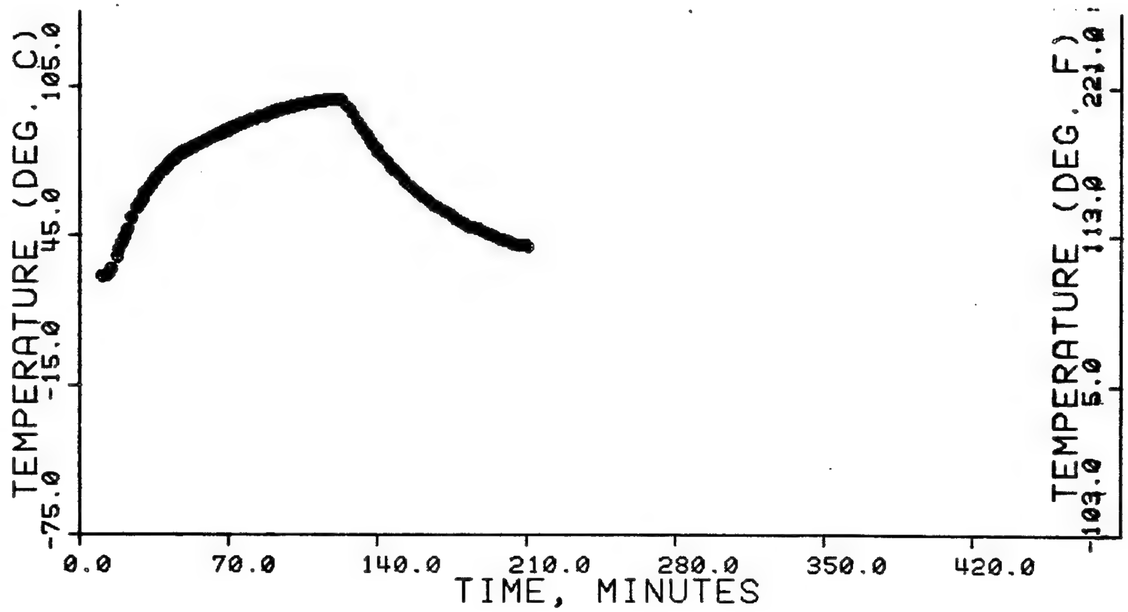


Figure 12. Response of Strain Gage Pair 2 on Bottom PWB During 0.6 g/cm^3 PSBF Thermal Cycle 1



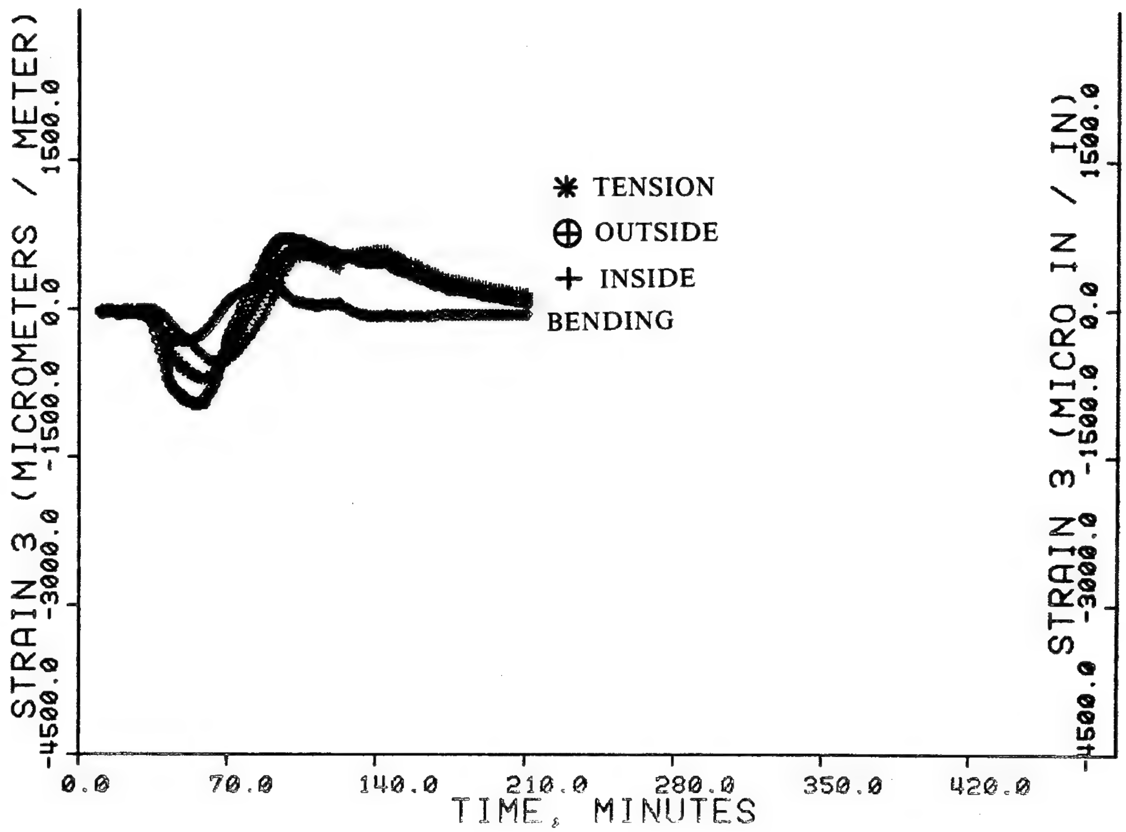


Figure 13. Response of Strain Gage Pair 3 on Vertical PWB During 0.4 g/cm³ PSBF Fusion

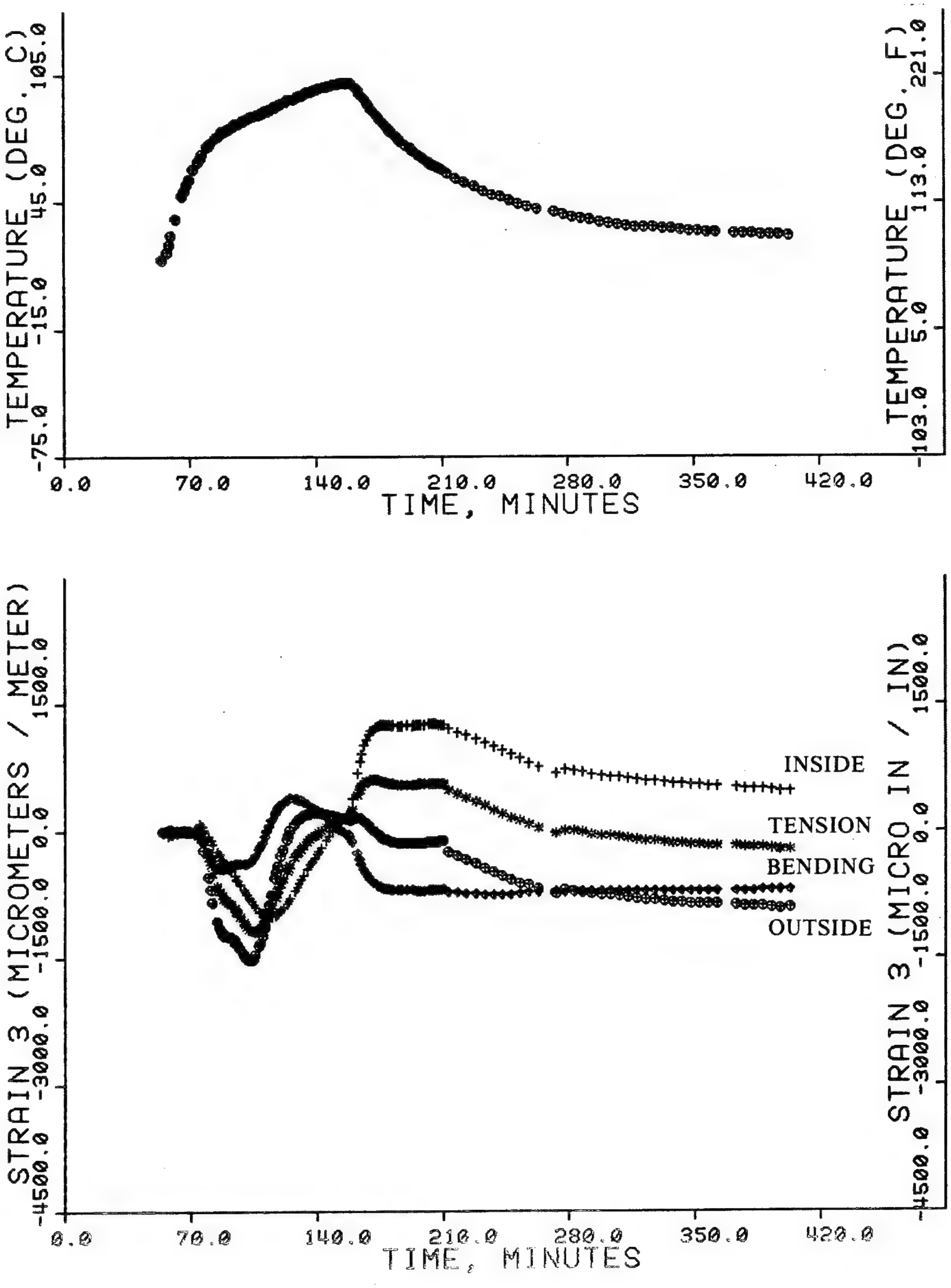
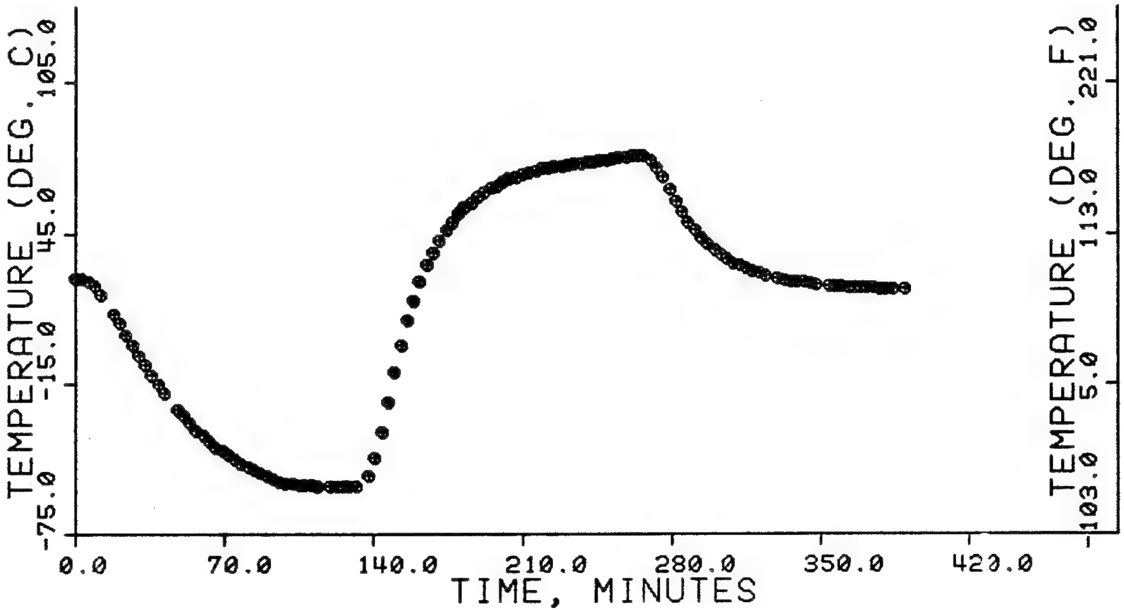


Figure 14. Response of Strain Gage Pair 3 on Vertical PWB During 0.6 g/cm³ PSBF Fusion



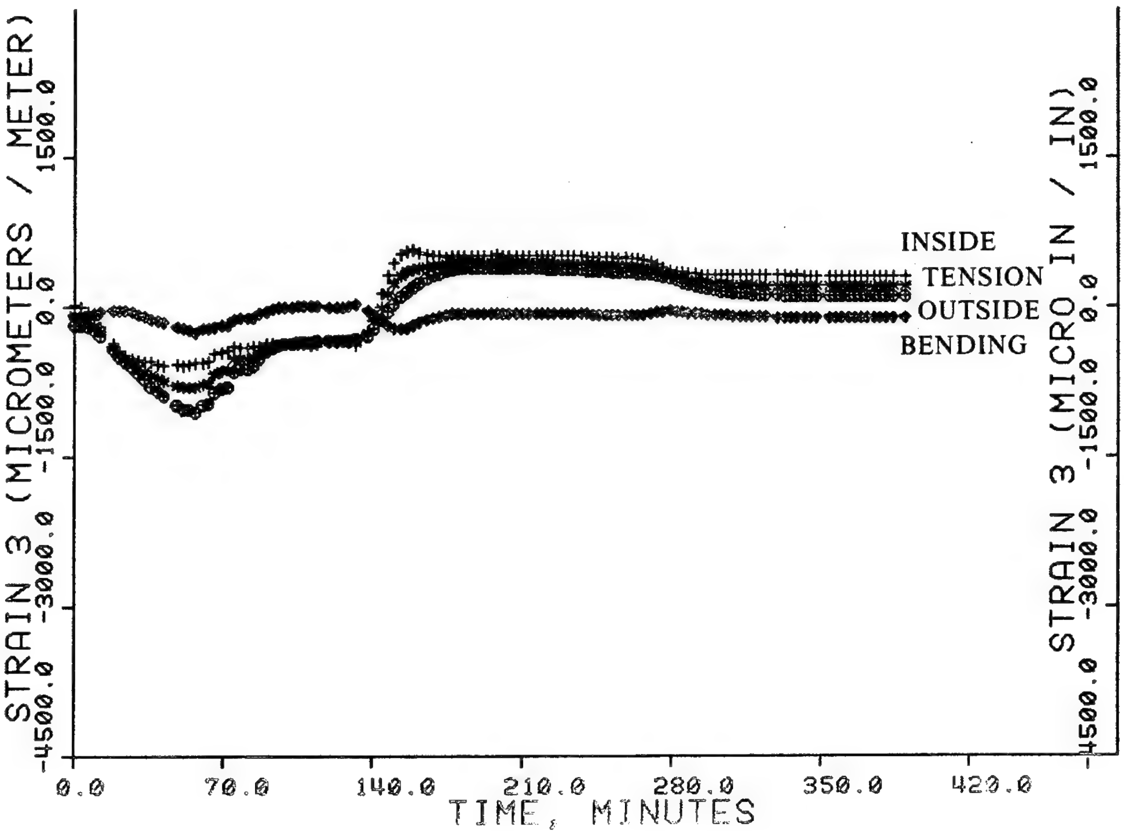
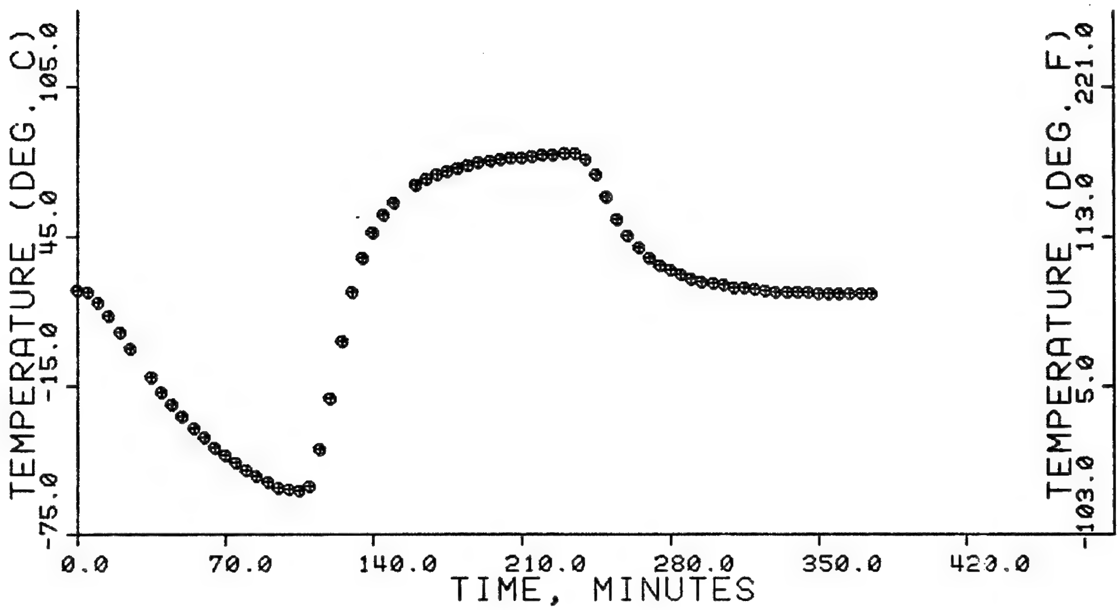


Figure 15. Response of Strain Gage Pair 3 on Vertical PWB During 0.4 g/cm³ PSBF Thermal Cycle 1



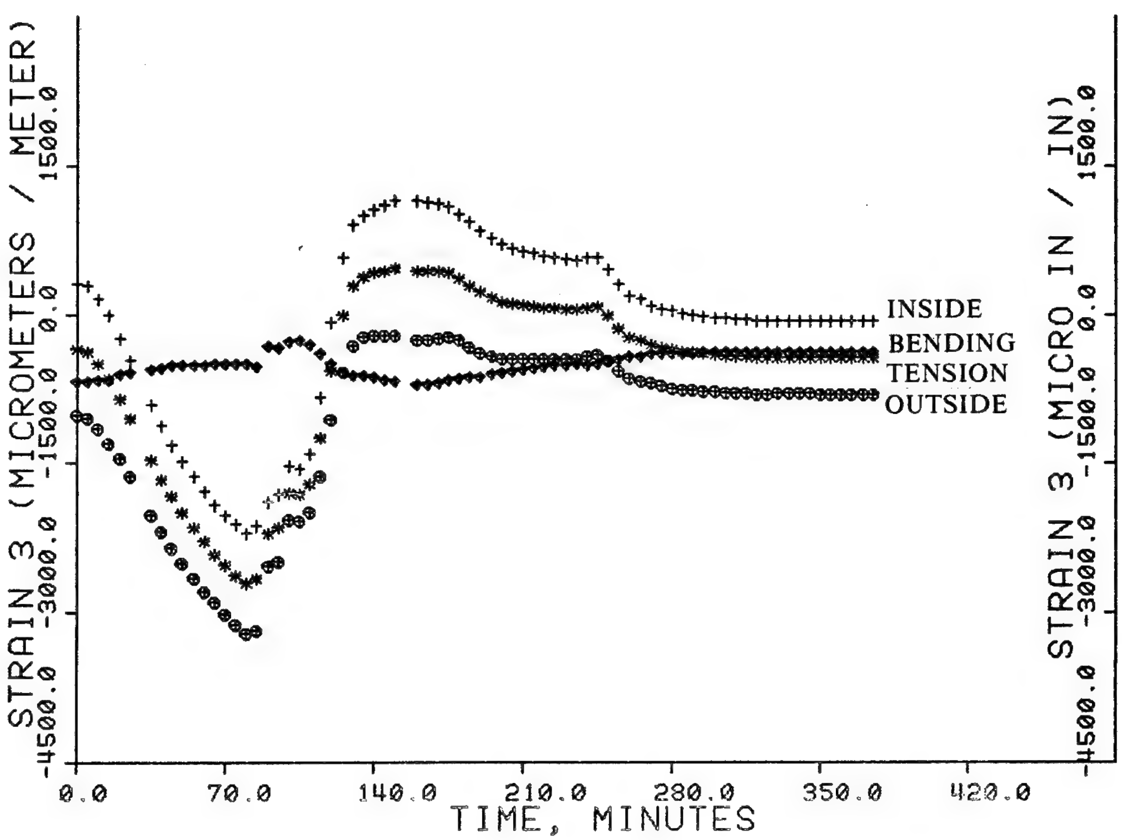


Figure 16. Response of Strain Gage Pair 3 on Vertical PWB During 0.6 g/cm³ PSBF Thermal Cycle 1

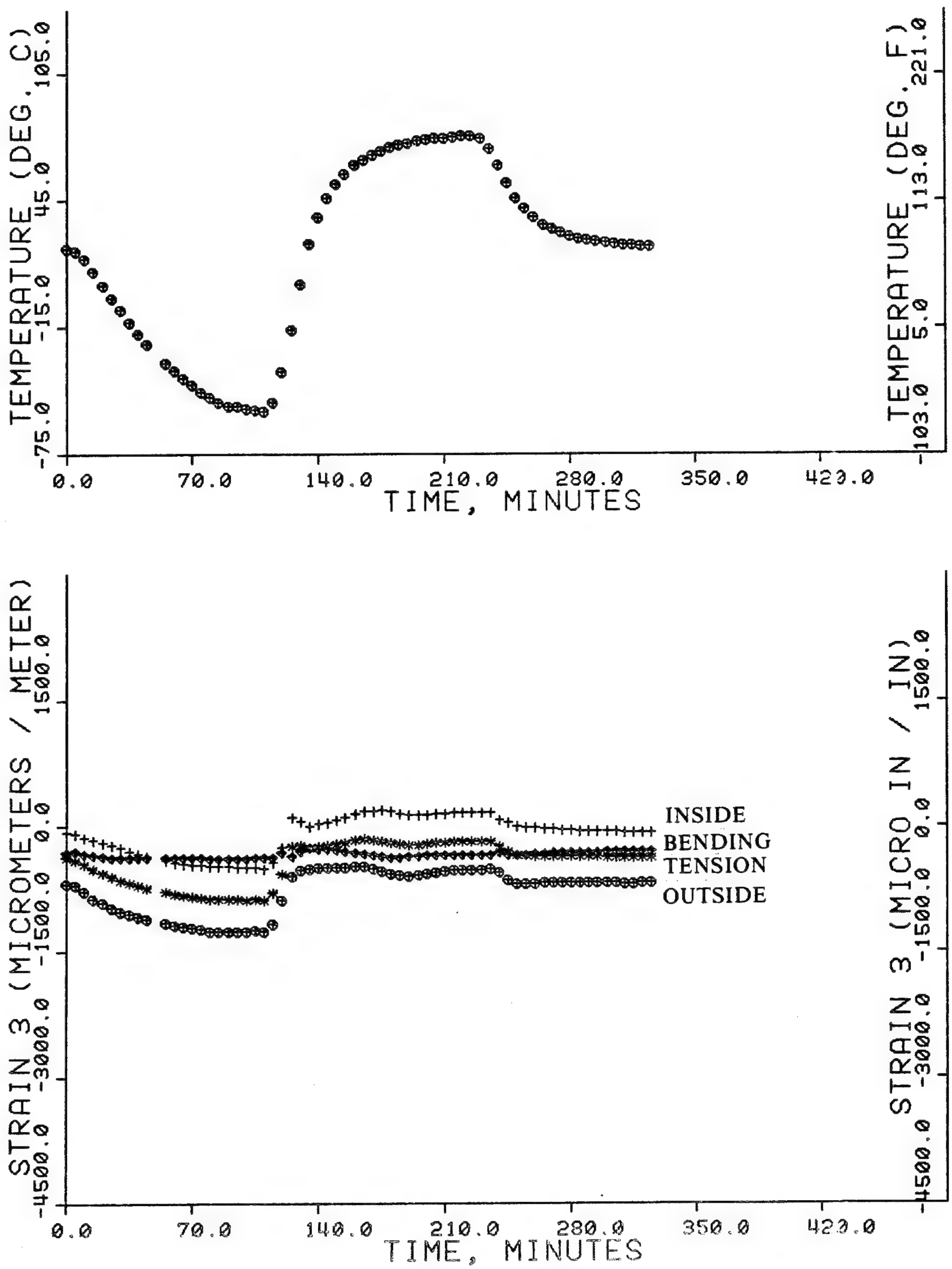
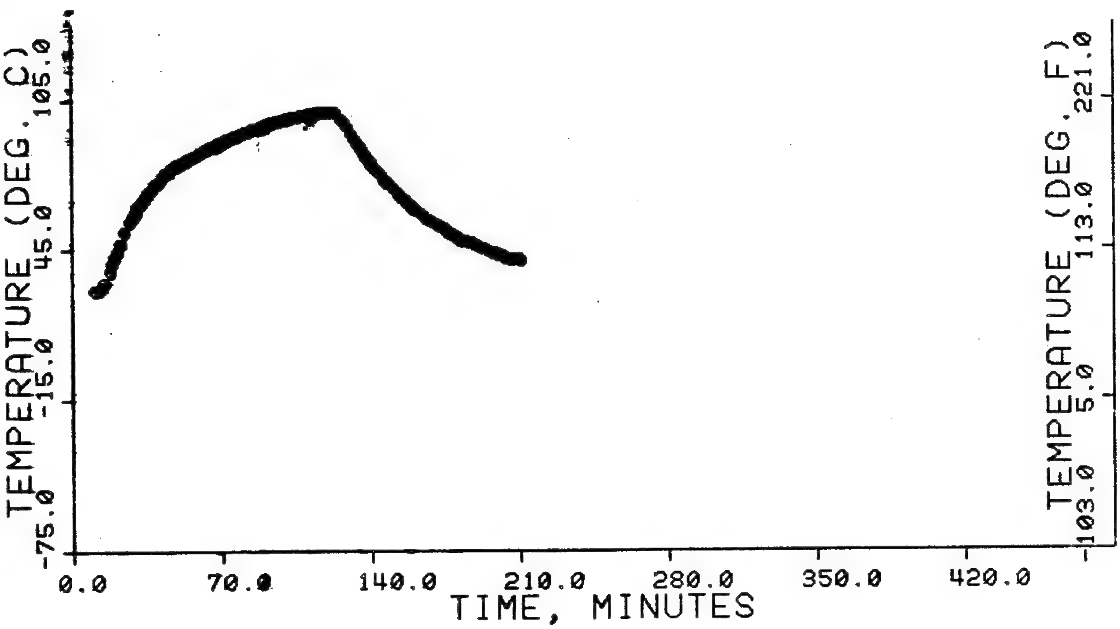


Figure 17. Response of Strain Gage Pair 3 on Vertical PWB During 0.6 g/cm^3 PSBF Thermal Cycle 7



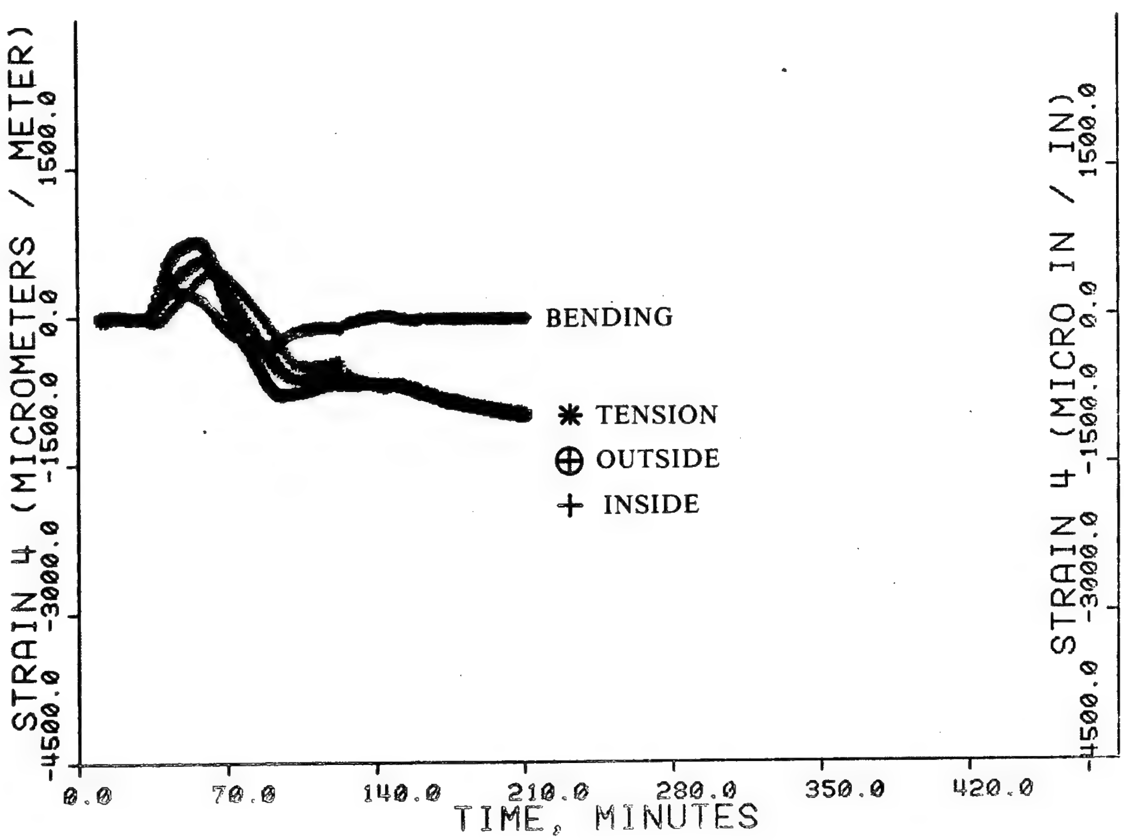


Figure 18. Response of Strain Gage Pair 4 on Vertical PWB During 0.4 g/cm^3 PBSF Fusion

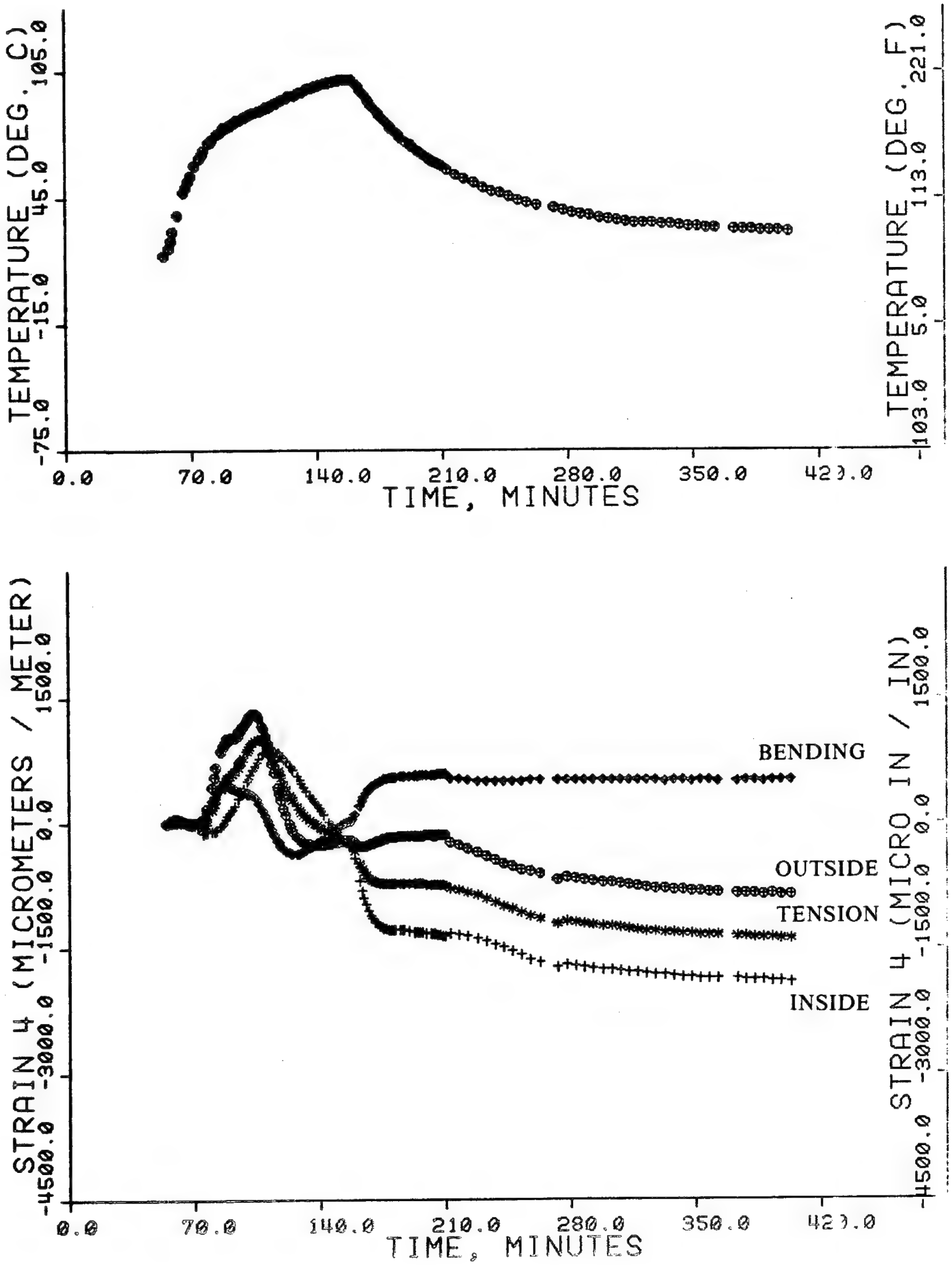
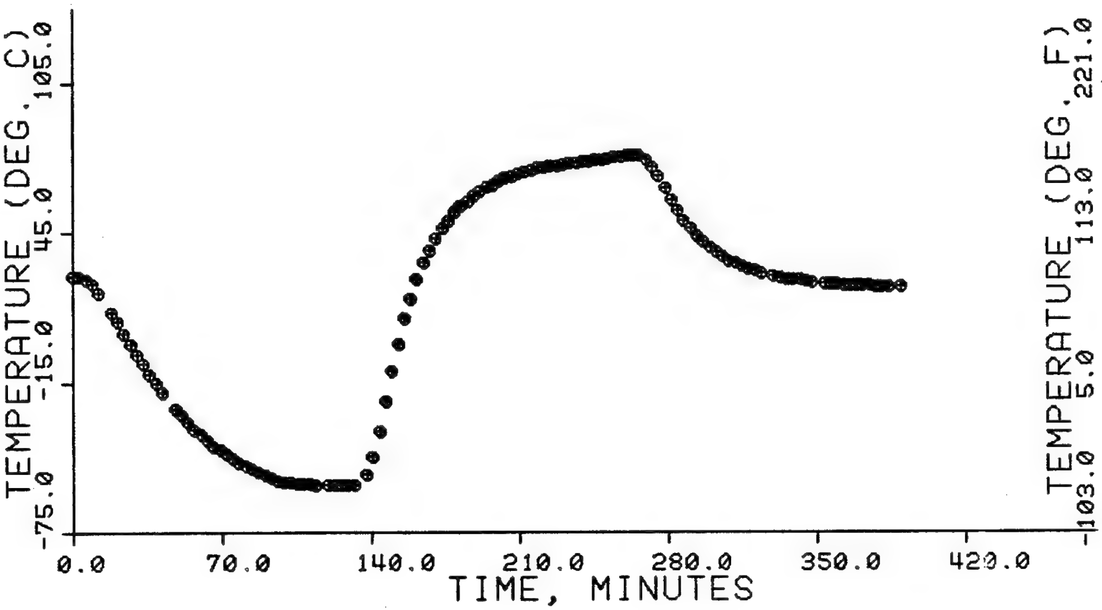


Figure 19. Response of Strain Gage Pair 4 on Vertical PWB During 0.6 g/cm³ PSBF Fusion



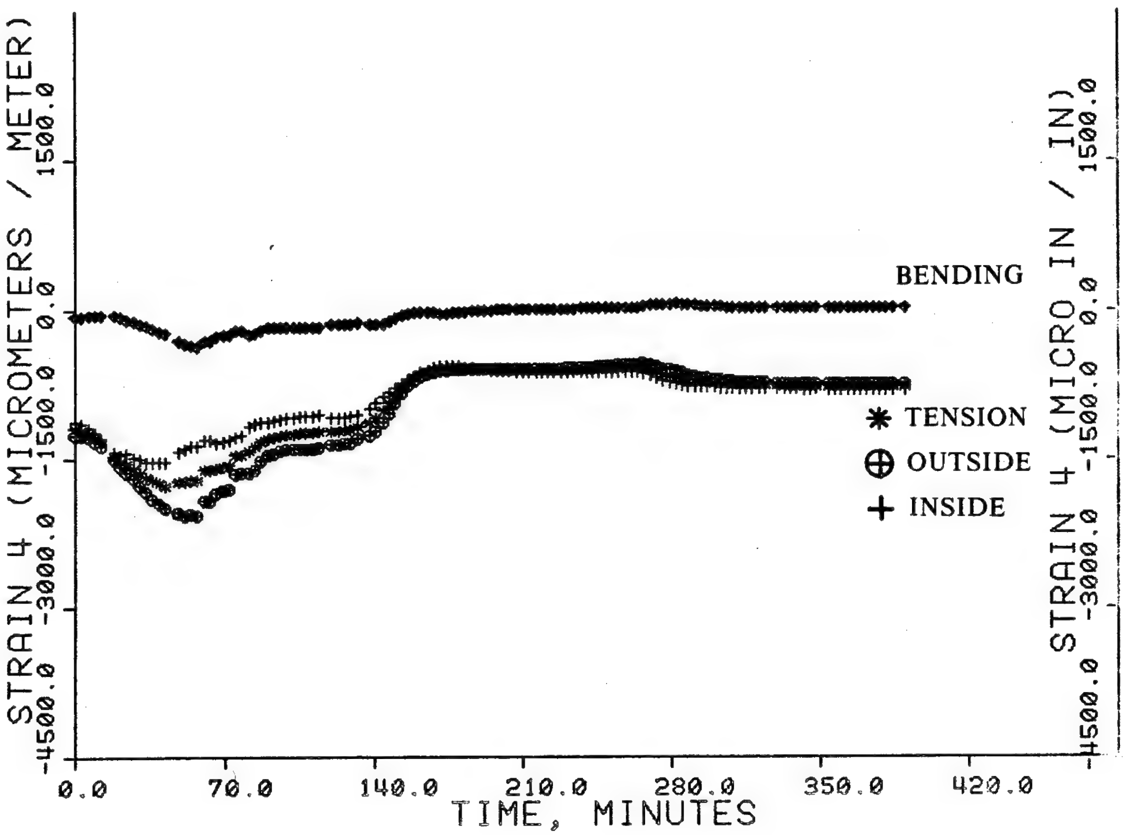


Figure 20. Response of Strain Gage Pair 4 on Vertical PWB During 0.4 g/cm^3 PSBF Thermal Cycle 1

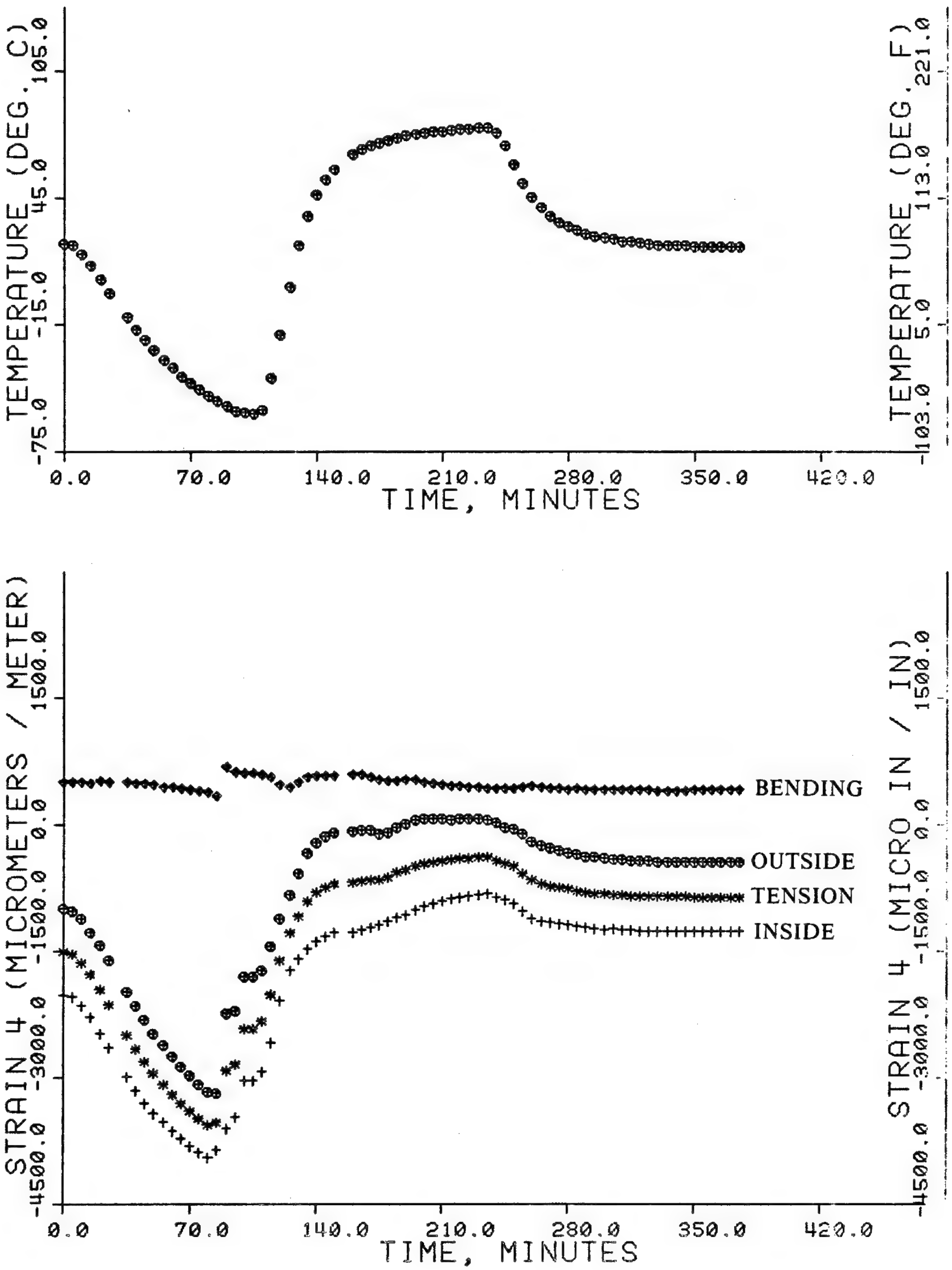


Figure 21. Response of Strain Gage Pair 4 on Vertical PWB During 0.6 g/cm^3 PSBF Thermal Cycle 1

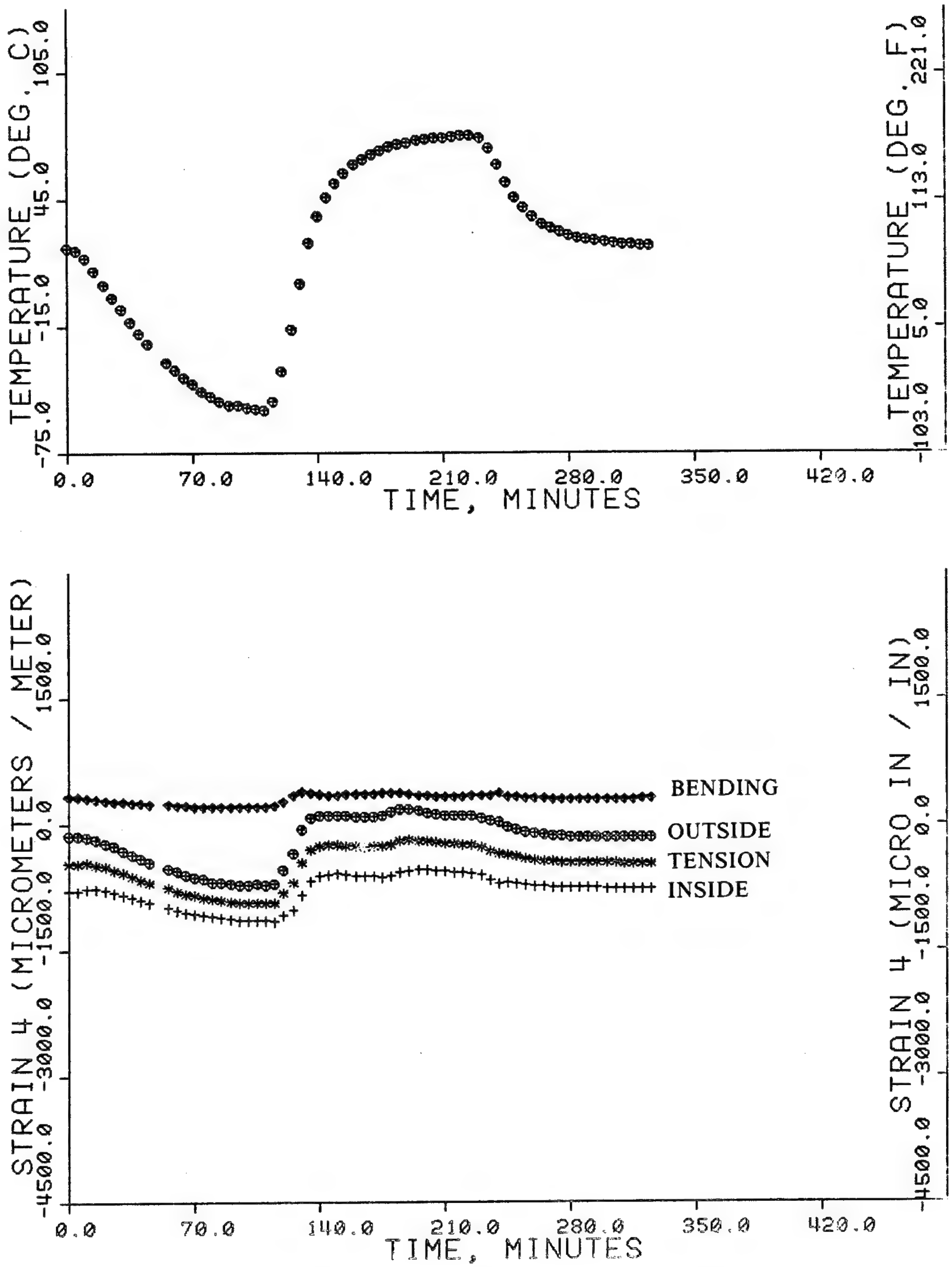


Figure 22. Response of Strain Gage Pair 4 on Vertical PWB During 0.6 g/cm³ PSBF Thermal Cycle 7

Reliable data on the response of the lateral force transducer, F, (Figures 1 and 2) were acquired only for 0.2 and 0.3 g/cm^3 PSBF. After all testing, this transducer was found to be filled with solid polystyrene, and thus not free to move. A close analysis of the data indicated that the problem first occurred following the depotting of 0.3 g/cm^3 PSBF.

Figures 23 and 24 show the force during 0.2 and 0.3 g/cm^3 PSBF fusion. In both cases, the downward force resulting from filling the unit relaxes during the fusion cycle. Figures 25 and 26 show the first thermal cycle for 0.2 and 0.3 g/cm^3 PSBF, respectively. Only minor changes in the peak height and detail occurred with later thermal cycles. The force direction is downward for all temperatures, except occasionally for the very low force levels.

The lateral deflection transducer D (Figures 1 and 2) also gave reliable data for only the first two PSBF densities. Very little change occurred in going from 0.2 to 0.3 g/cm^3 PSBF for the fusion cycles (Figures 27 and 28). The deflection caused by filling the unit with polystyrene beads is quickly relaxed during heat-up to the fusion temperature. Figure 29 shows the deflection for 0.2 g/cm^3 thermal cycle 1, and is nearly identical to all thermal cycles for both densities. All deflections are downward for fusion and thermal cycles.

Figures 30 to 32 show the pressure transducer data for fusion of 0.2, 0.4, and 0.6 g/cm^3 PSBF. This transducer was made from a strain-gaged transistor and was mounted between the bottom circular PWB and the metal base. The first thermal cycle data are exhibited in Figures 33 to 35.

Successively larger pressure changes do occur for higher PSBF densities. Also, transient pressure "spikes" occur at the beginning of each large temperature change. Their direction toward positive pressure corresponds to a pulling outward of the top of the transistor can and appears as such regardless of whether the temperature is increasing or decreasing. The reason for these transients is not yet understood. Some thermal ratcheting toward larger magnitude inward-directed pressure does occur with successive thermal cycles (as shown by Figure 36 for 0.6 g/cm^3 PSBF thermal cycle 7, when compared to Figure 35).

Discussion of Results

The data previously mentioned may be interpreted by considering the mechanisms involved during the fusion and thermal cycles. When the unit is poured full of pre-expanded individual polystyrene beads and heated, the beads expand and are fused to each other to form a solid foam throughout the interior of the unit. However, during heat-up, the beads move around to accommodate the forces from filling and from mismatch of coefficient of thermal expansion

Text Continued on p. 51

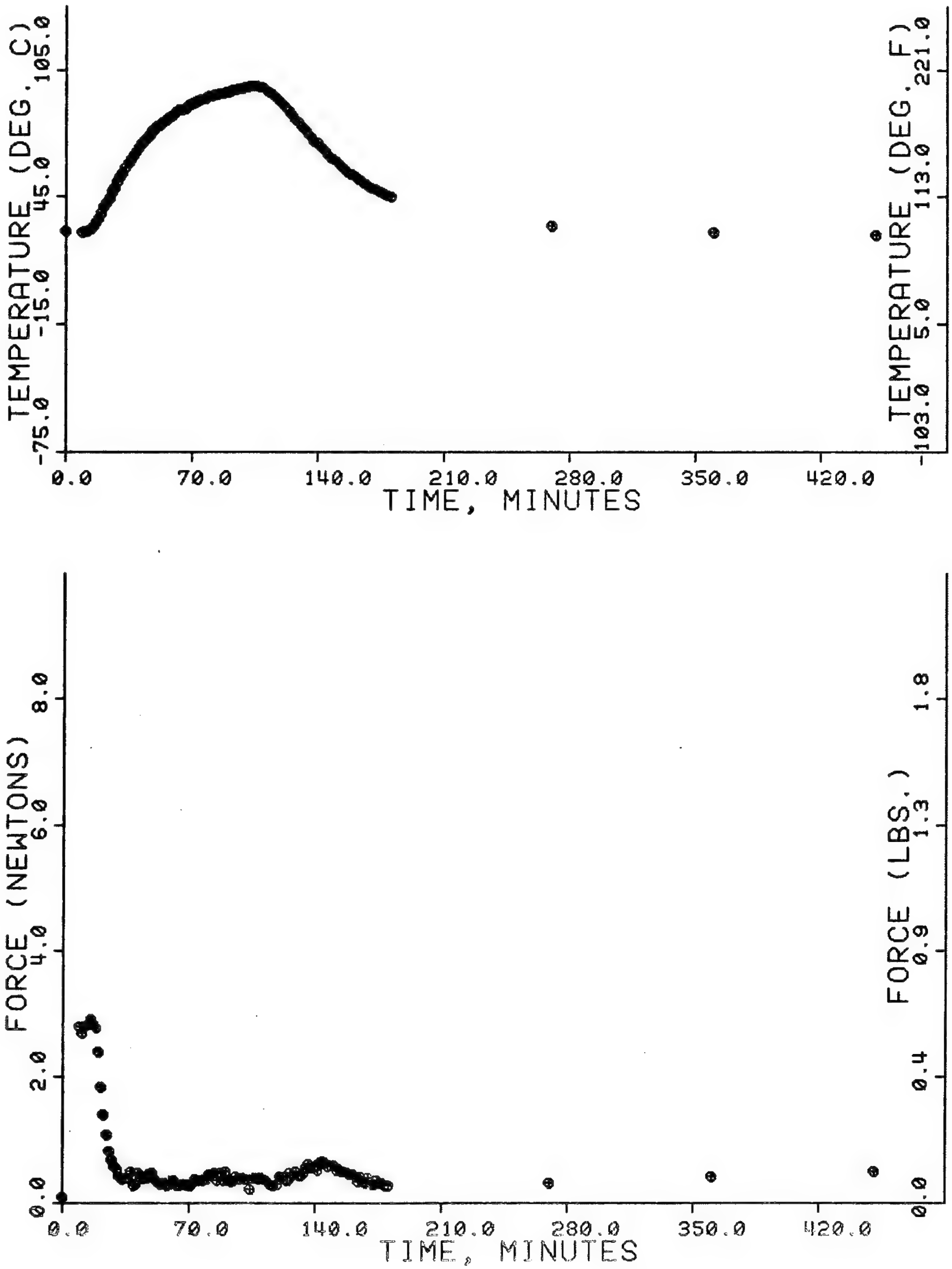


Figure 23. Lateral Force During 0.2 g/cm^3 PSBF Fusion

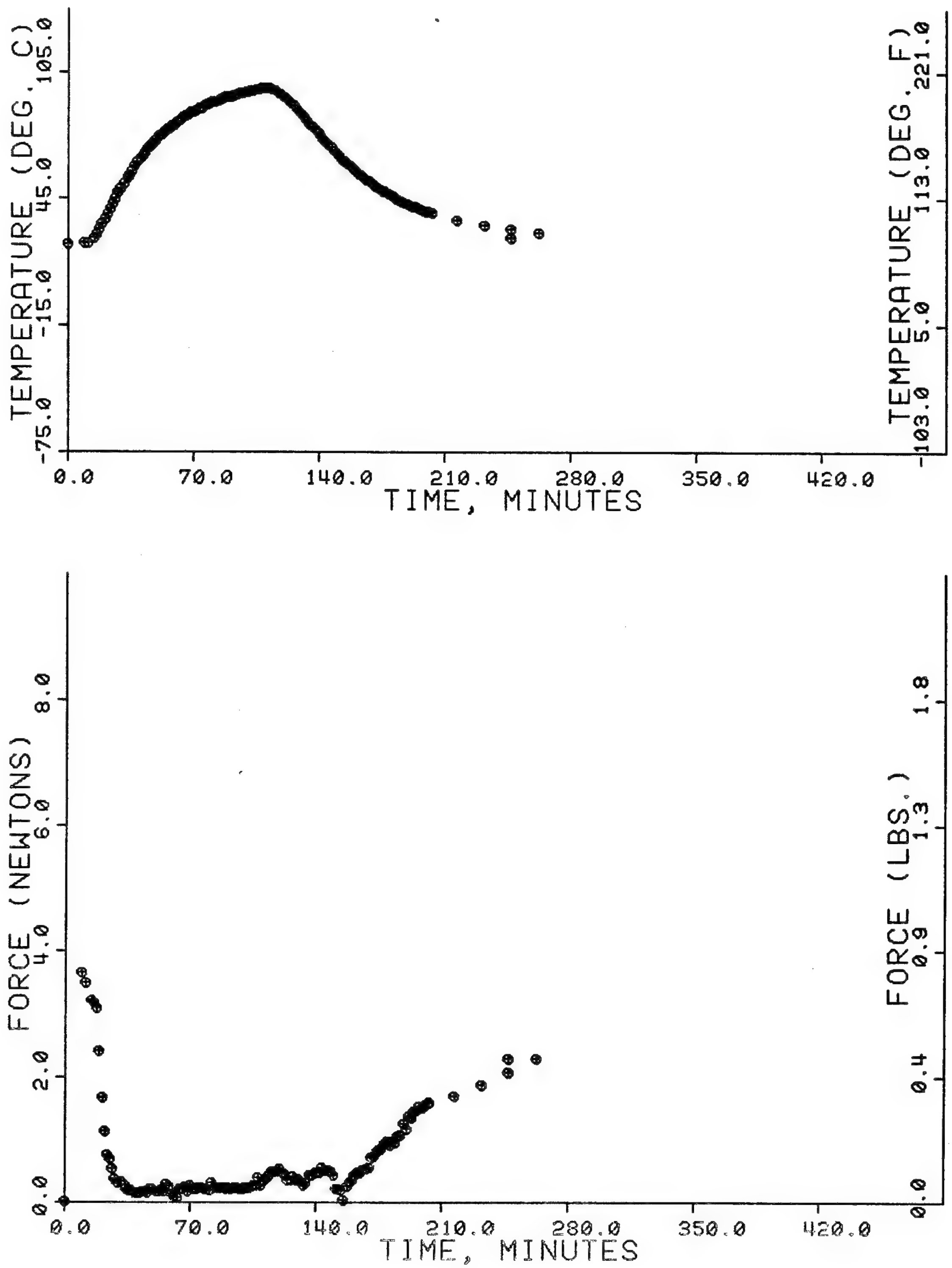


Figure 24. Lateral Force During 0.3 g/cm³ PSBF Fusion

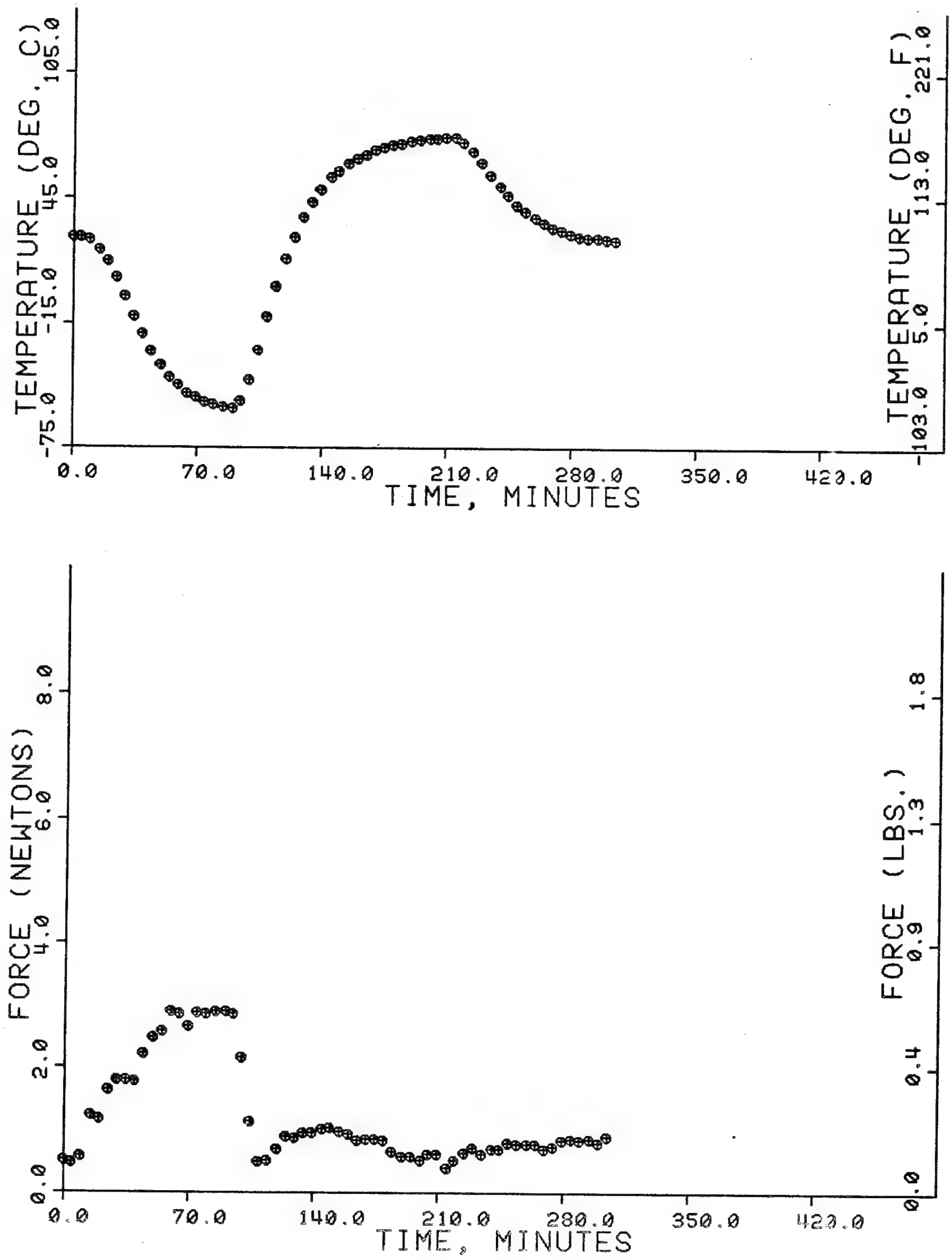


Figure 25. Lateral Force During 0.2 g/cm³ PSBF Thermal Cycle 1

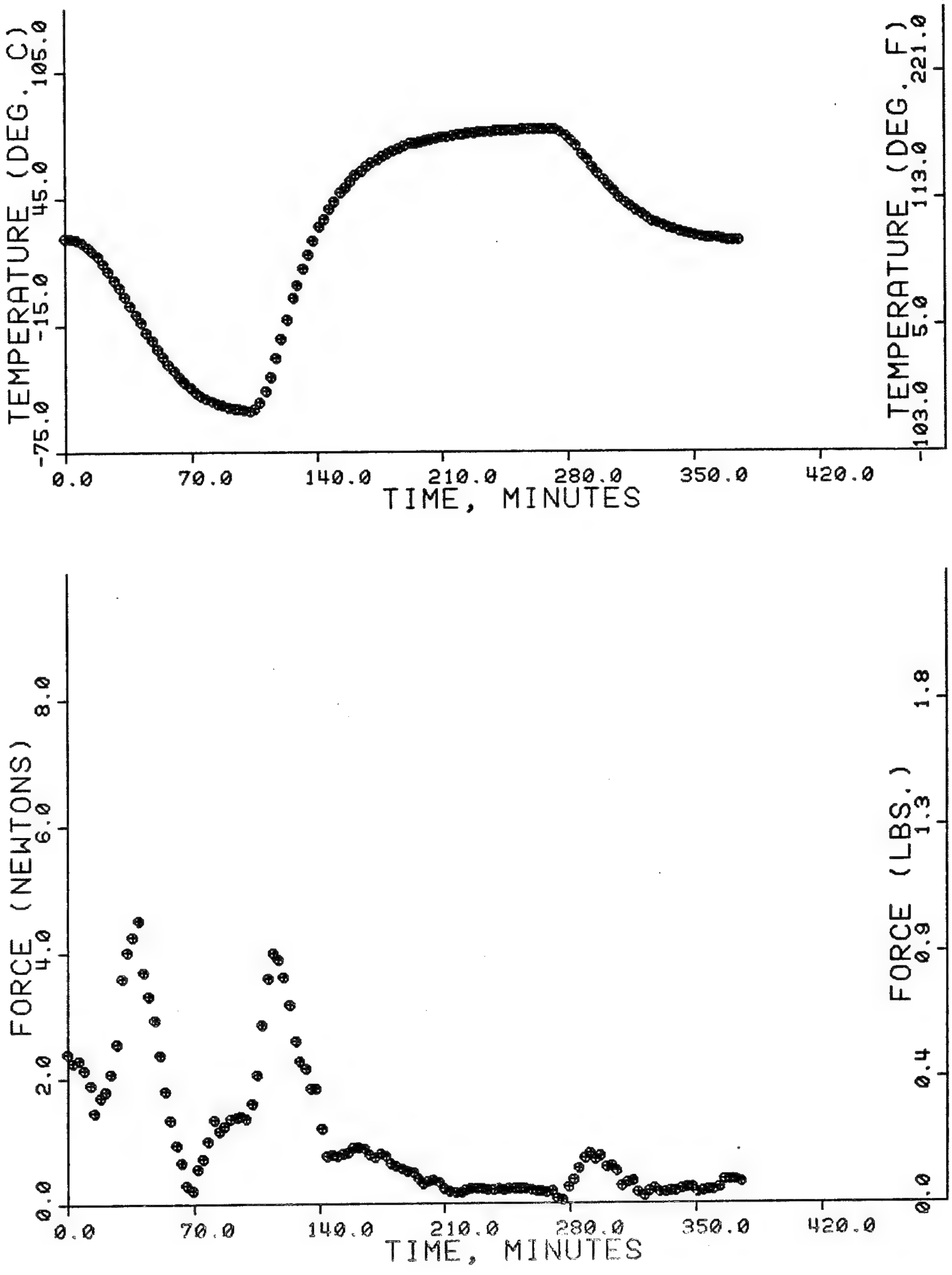


Figure 26. Lateral Force During 0.3 g/cm³ PSBF Thermal Cycle 1

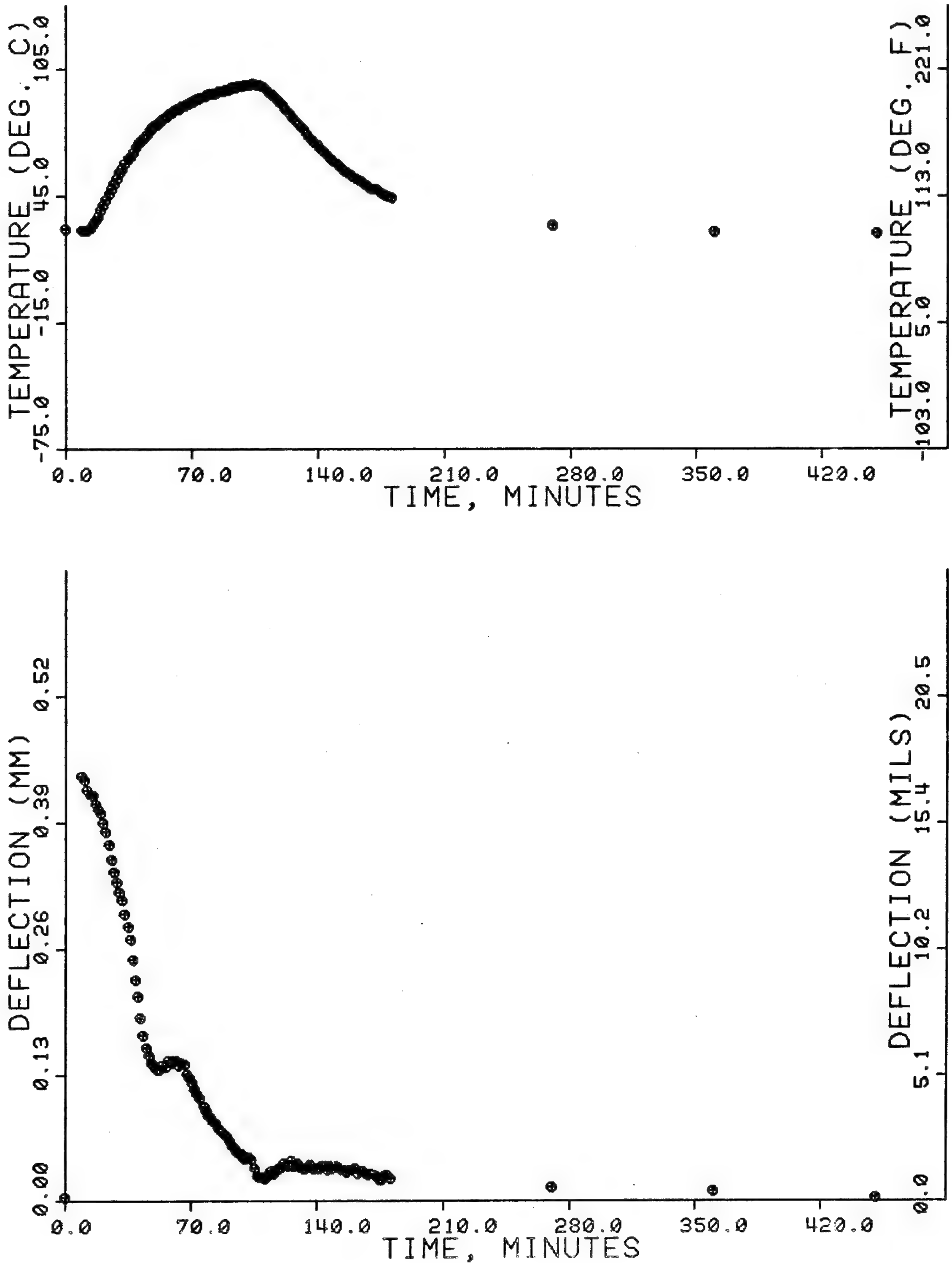


Figure 27. Lateral Deflection During 0.2 g/cm^3 PSBF Fusion

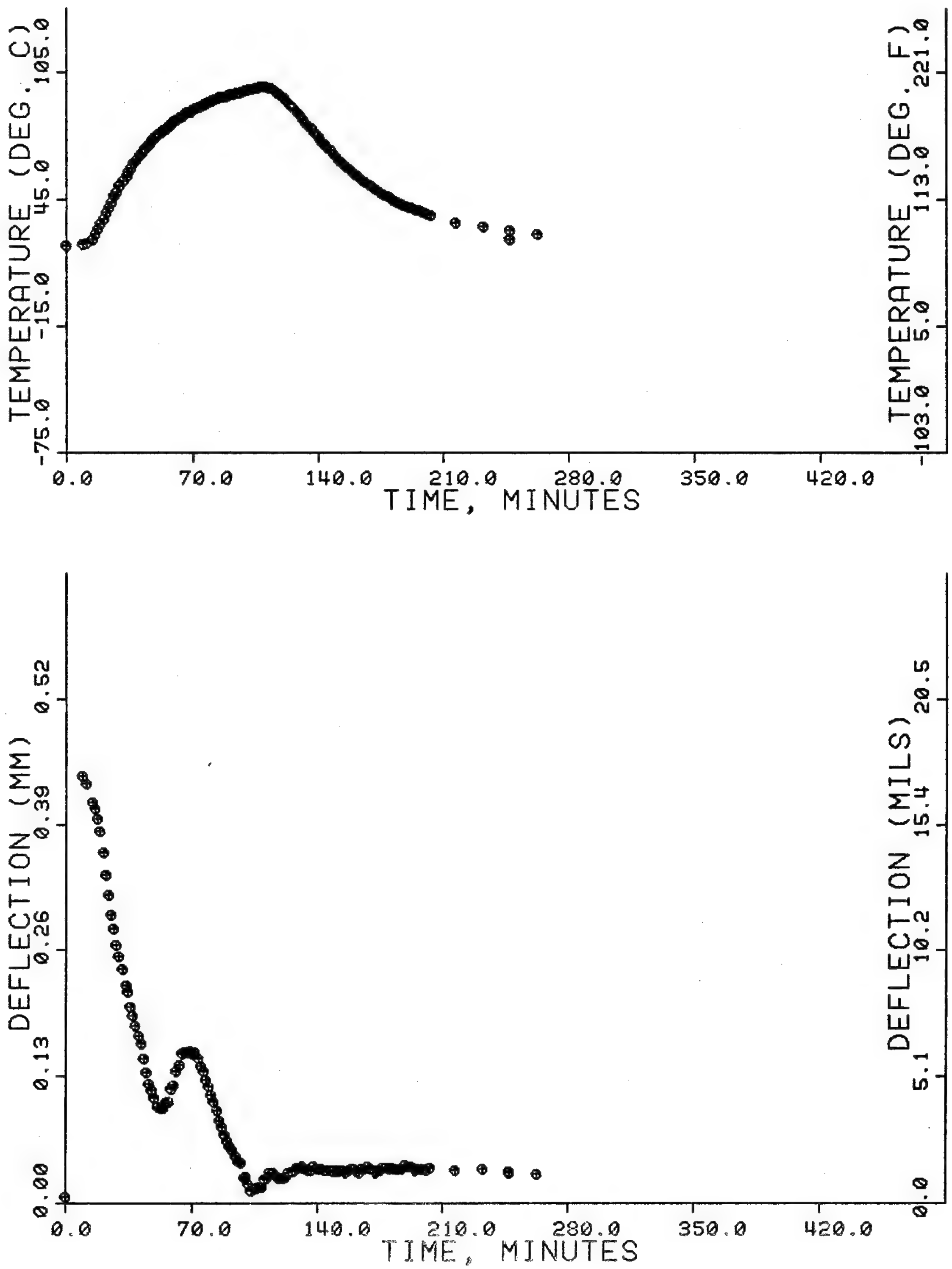


Figure 28. Lateral Deflection During 0.3 g/cm³ PSBF Fusion

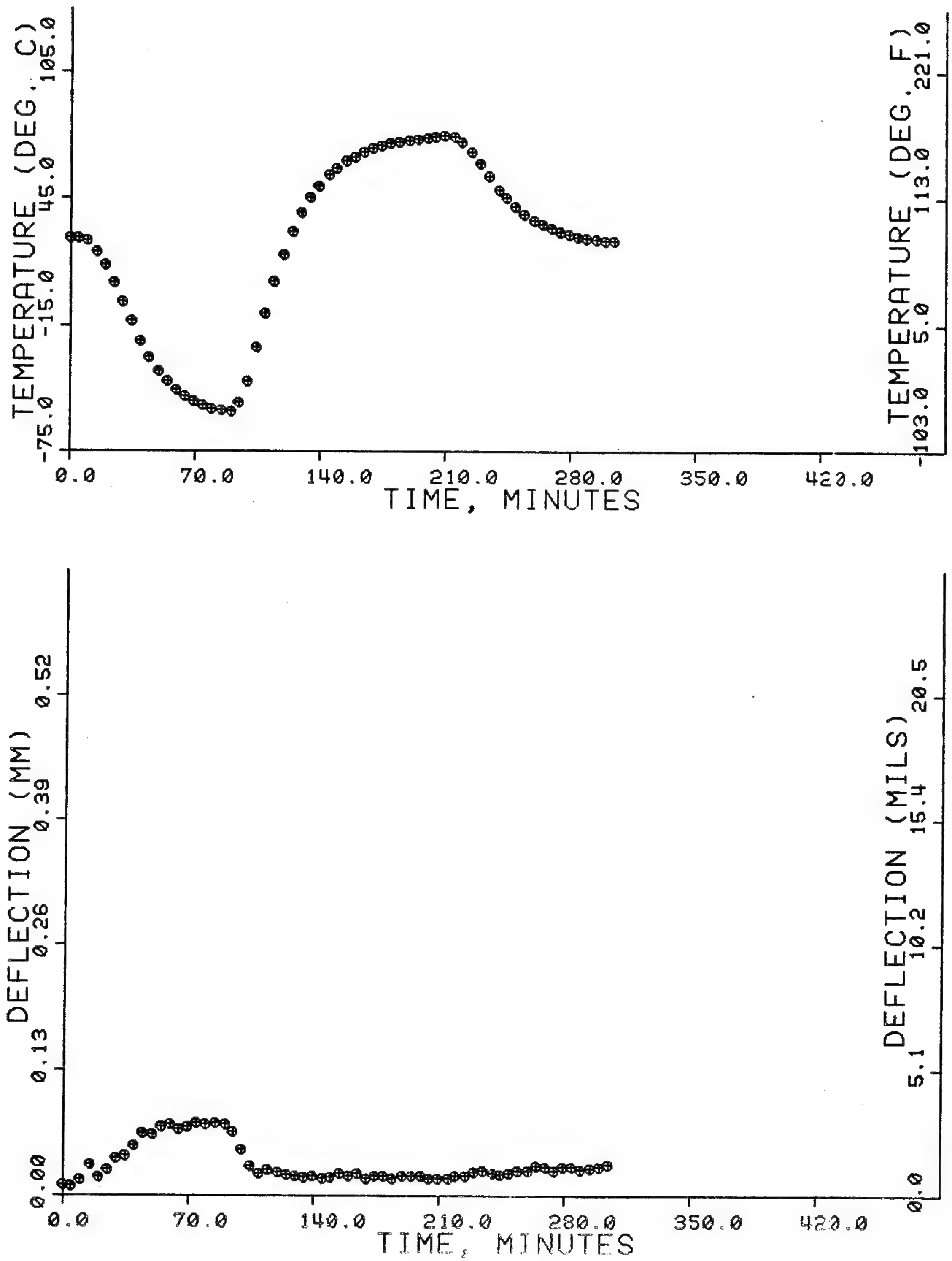


Figure 29. Lateral Deflection During 0.2 g/cm³ PSBF Thermal Cycle 1

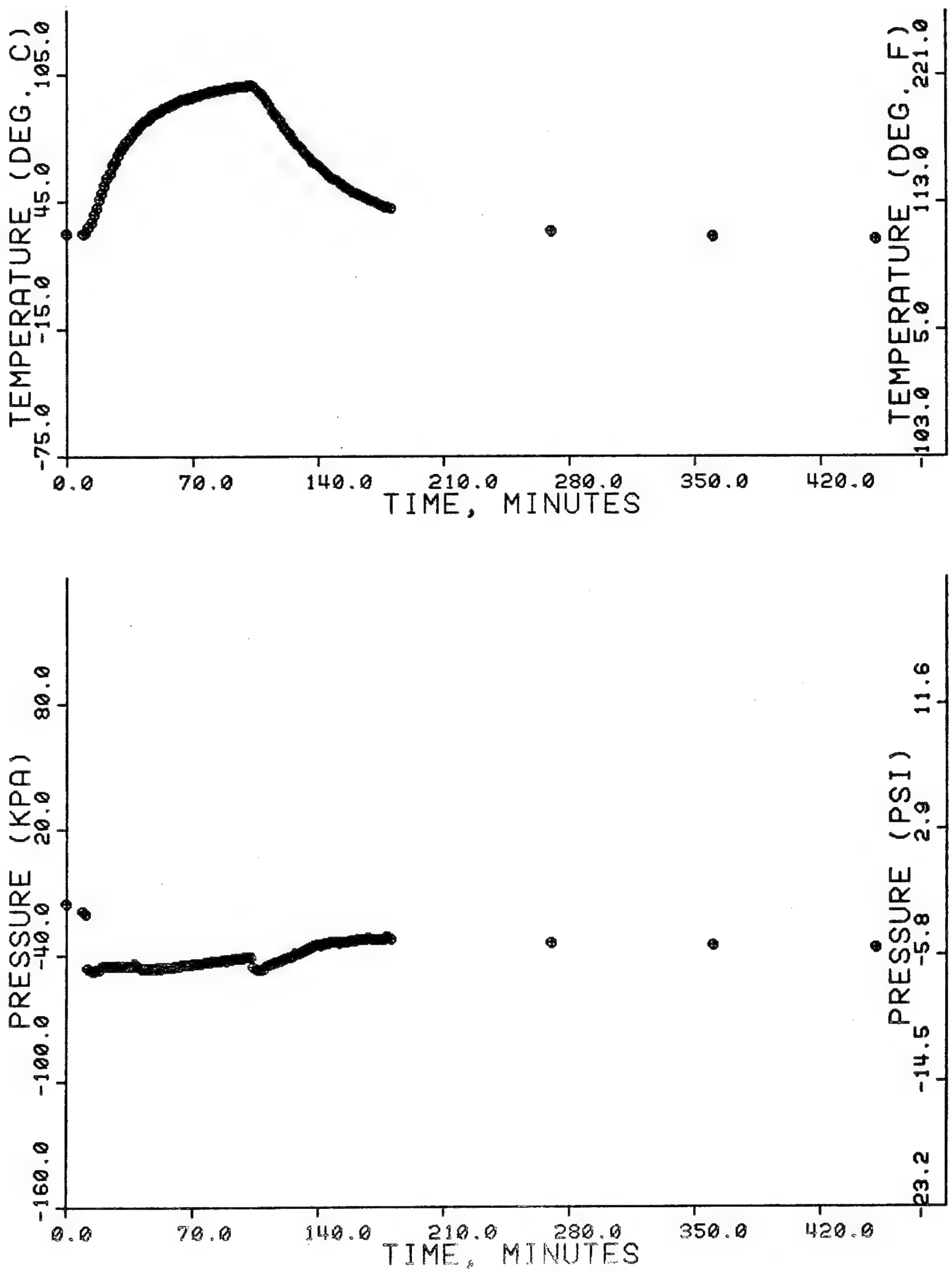


Figure 30. Pressure During 0.2 g/cm³ PSBF Fusion

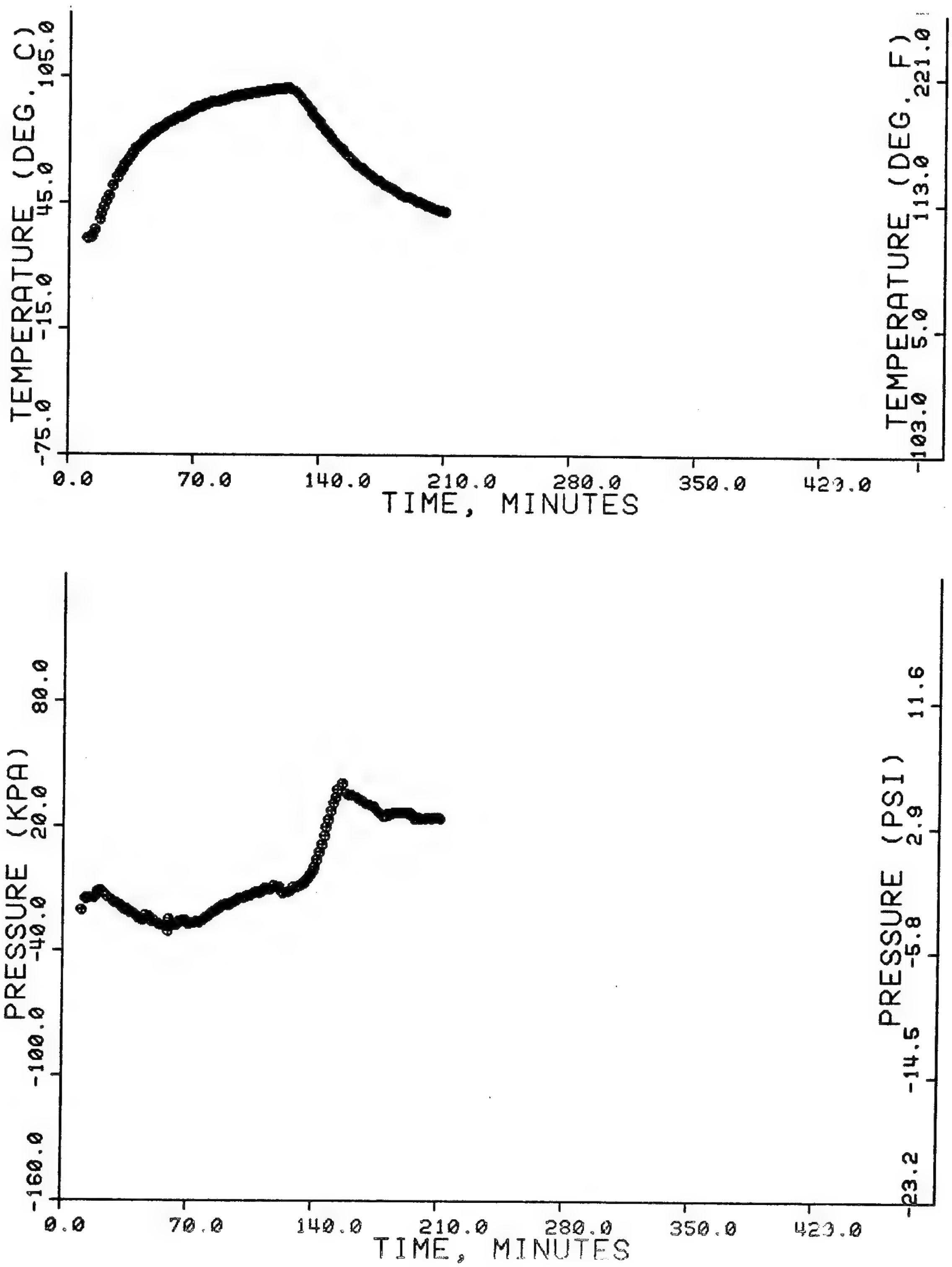
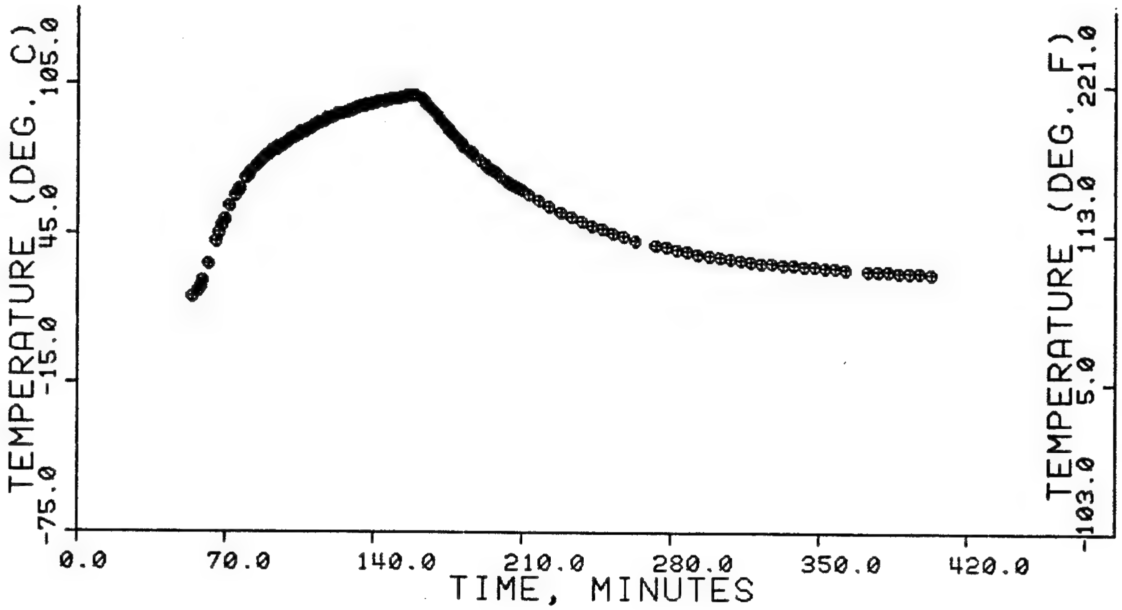


Figure 31. Pressure During 0.4 g/cm³ PSBF Fusion



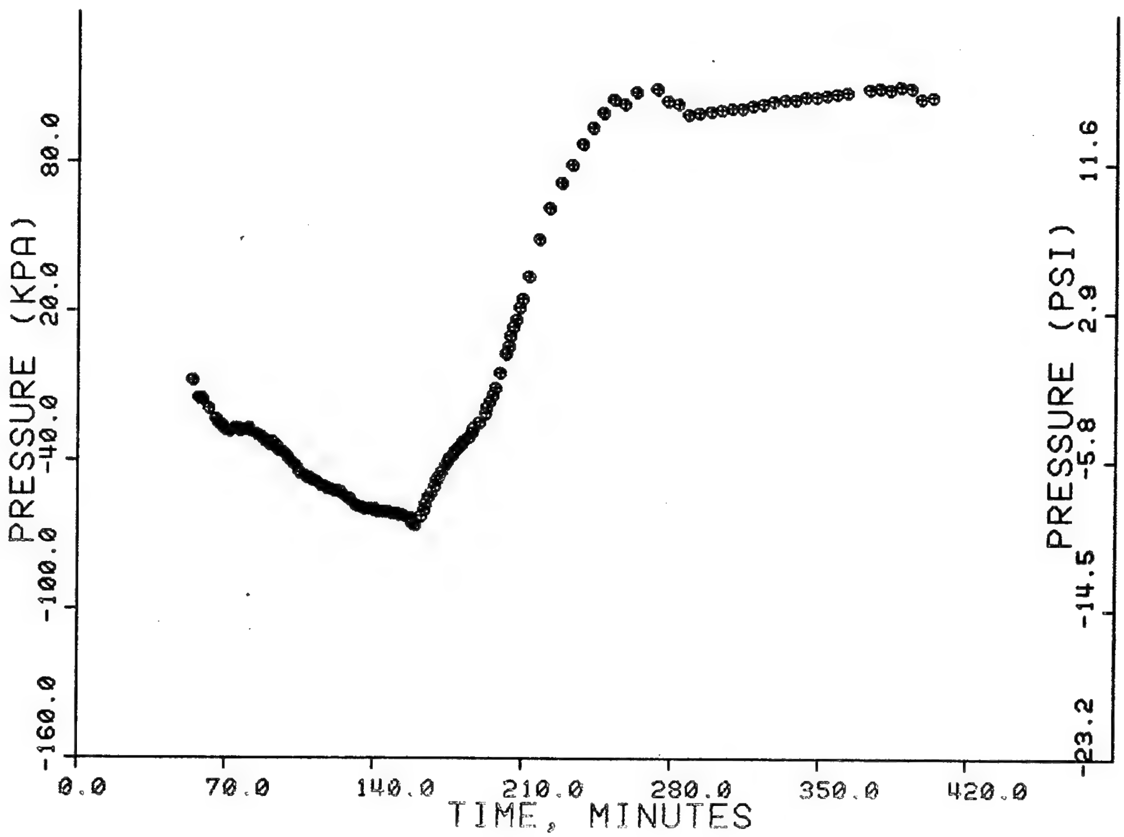


Figure 32. Pressure During 0.6 g/cm³ PSBF Fusion

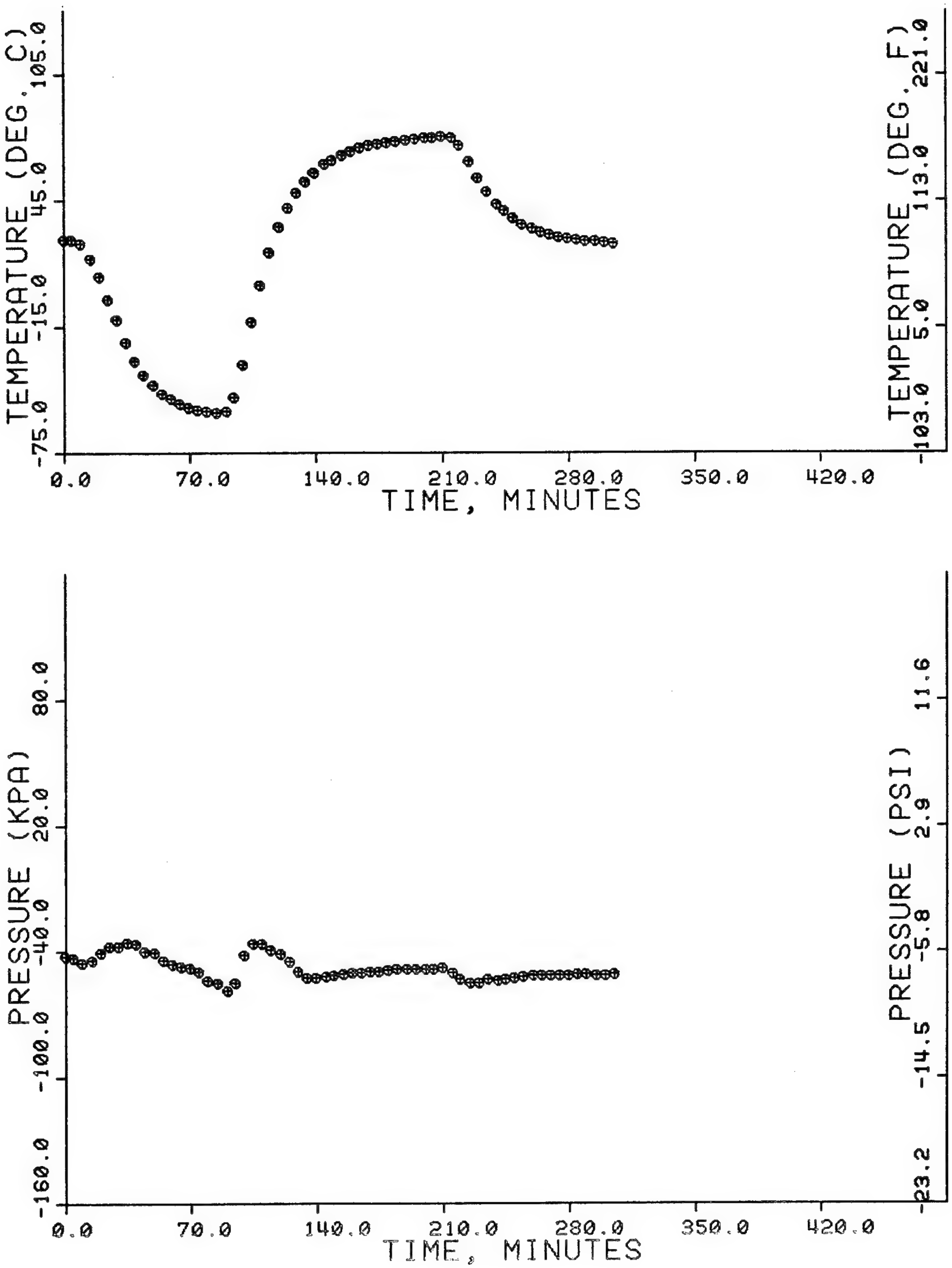


Figure 33. Pressure During 0.2 g/cm³ PSBF Thermal Cycle 1

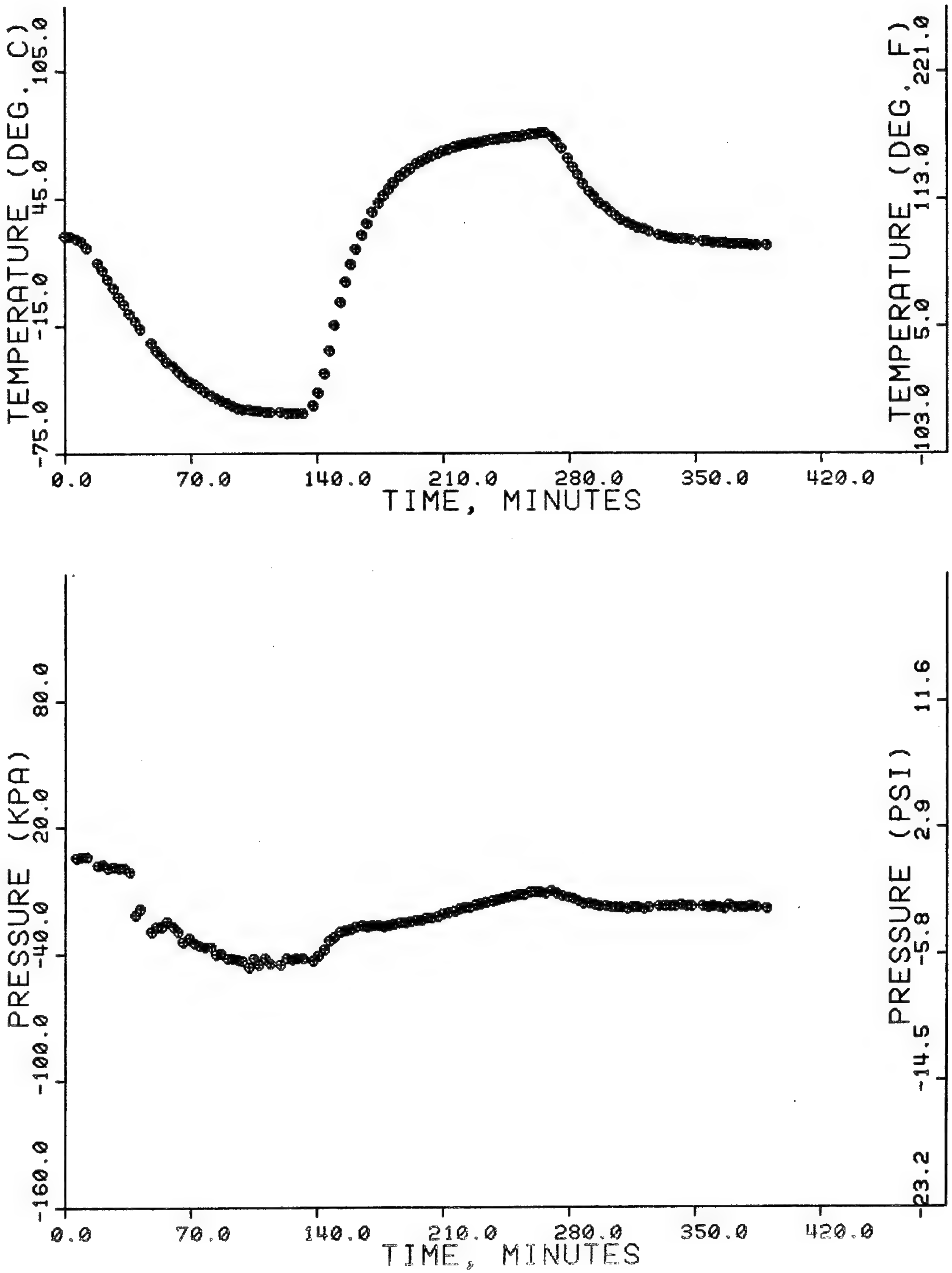


Figure 34. Pressure During 0.4 g/cm³ PSBF Thermal Cycle 1

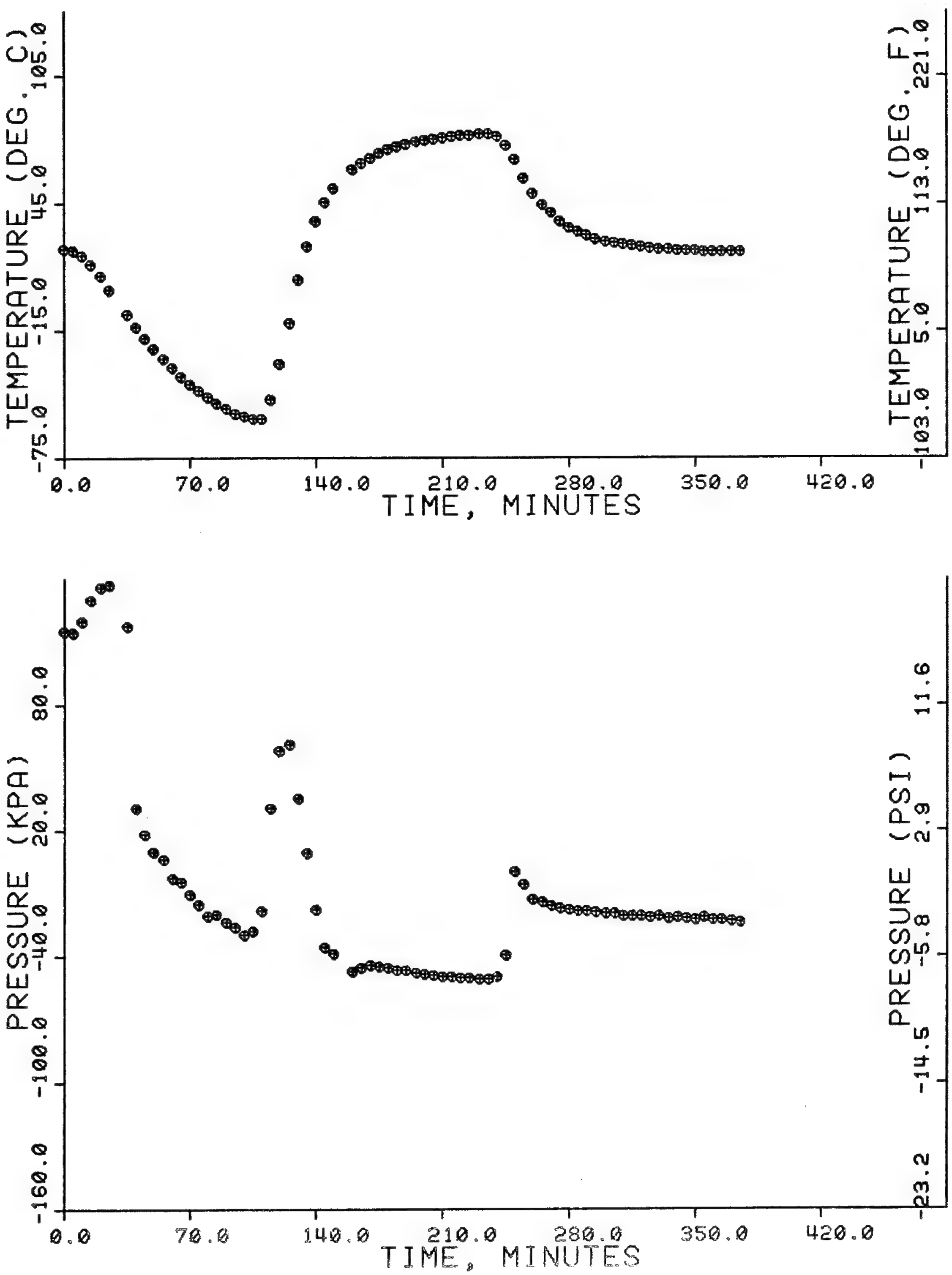


Figure 35. Pressure During 0.6 g/cm³ PSBF Thermal Cycle 1

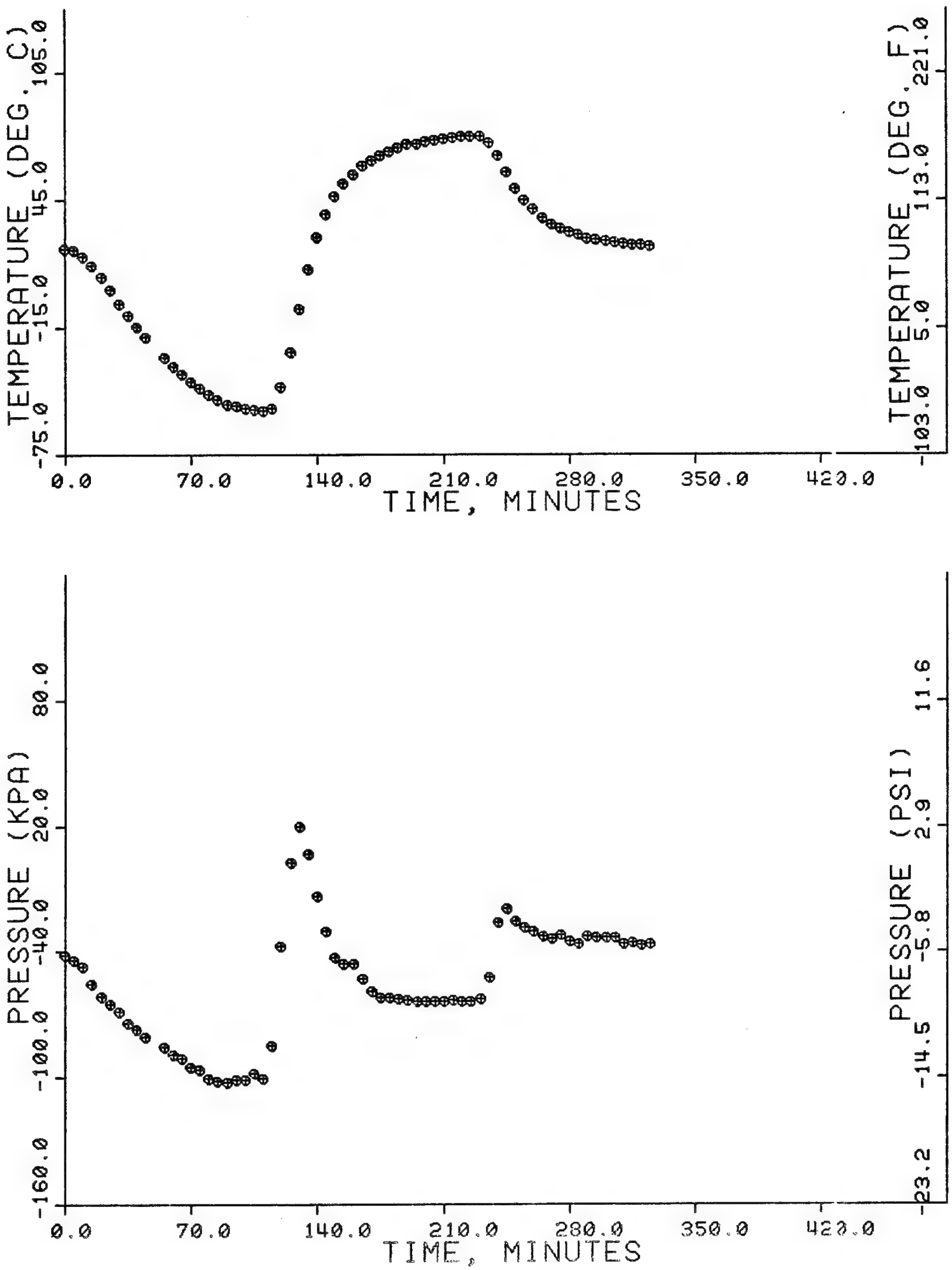


Figure 36. Pressure During 0.6 g/cm³ PSBF Thermal Cycle 7

of the container, PWBs, transducers, and other interior items. Such relaxation occurs for the lateral force and deflection previously mentioned. Because the fused PSBF is soft, loads at the end of the fusion cycle are very low. The unit then is cooled to ambient and the PSBF elastic modulus rapidly increases. The mismatch of coefficient of thermal expansion then generates loads and deflections. Thus, most experimental data are not zero at ambient after fusion.

The unit never gets as hot during the thermal cycles as it does during the fusion cycle, so the PSBF always has significant stiffness. At the lowest temperature, the thermal mismatch is greatest, so the loadings and deflections should be greatest. Most of the experimental data verified this.

If the combination of thermal mismatch and temperature change is great enough, progressive relaxation or thermal ratcheting can occur. This ratcheting is caused by nonrecoverable deformation by at least one material in a closed action-reaction load loop. For example, the PSBF could yield or crack at low temperature. In an actual production unit, a solder joint could yield or a component lead could bend beyond the elastic limit. Behavior during the next thermal cycle will then be different. Such thermal cycle changes are seen for Strains 3 and 4 and the pressure data previously presented.

In general, as the density of the PSBF increases, so do the elastic modulus and the tensile and compressive strengths. For a given density of PSBF, the values of these three properties increase as the temperature decreases. These two factor conspire to produce the severest loadings for the highest density PSBF at the lowest temperature of the thermal cycle. This is qualitatively true for the PWB strains and pressure data.

Large loadings also can be expected when the temperature is changing rapidly during heat-up of the fusion cycle or starting from one equilibrium temperature to another during thermal cycling. The unit is then in a transient thermal state with transient forces and deflections. Such effects are sensitive to both direction and position. Hence, PWB deflection shows transient movement during heat-up to the fusion temperature in Figures 3 and 4. The pressure transducer shows transient "spikes" during thermal cycles in Figures 33 through 36.

The influence of adjacent items to a given transducer which may act as restraints or "pinning points" for the encapsulant PSBF should be considered. The items' size, shape, and proximity are all important. Such restraints may change the magnitude or direction of a force, which is partly the reason for seeing some positive pressures. These pressures correspond to pulling the end of the transducer outward, an unexpected direction for PSBF, which bonds poorly to nearly all materials.

The study of Reference 3 showed similar results for a much different encapsulation unit geometry. Indeed, the response to a thermal cycle in that experiment yielded positive pressures at low temperatures and low or negative pressures at high temperatures. The magnitude of change for a thermal cycle was also larger than in this case, and no transient effects were seen. The earlier transducer faced downward from a PWB toward about 2.5 cm of PSBF and had a deflectometer housing beside it. The transducer in this test series faced parallel to the bottom PWB and toward about 5 cm of PSBF, but had the bottom PWB and the metal base within about 1 mm of the sides.

Conclusions

PWB deflection is not a problem. A little movement occurs after the initial accommodation during heat-up to the fusion temperature; however, since significant initial accommodation does occur, the interboard electrical insulating sheets must be included in production units. For other assemblies, rigid PWB spacers may be required.

For the locations measured, PWB strains should be safe for nearly all mounted components for all PSBF densities because all bending strains were small. Bending strains are most easily transmitted to mounted components and are a very severe condition for components like ceramic core resistors or ceramic case microcircuits.

PSBF of 0.2 and 0.3 g/cm^3 density should be safe for nearly all electronic components under the thermomechanical loadings produced here. Safe, although higher, loadings will occur for 0.4 g/cm^3 PSBF. Nearly identical severe loadings result for 0.5 and 0.6 g/cm^3 PSBF. These high densities may be able to crush some sensitive ceramic microcircuit covers or cause yielding and permanent inward "dishing" of metal transistor cans or microcircuit covers.

The most severe sideward loadings occur while filling the unit and clamping the cover shut. These are relaxed to near zero during fusion.

The most severe positive (or outward) pressure loadings occur during the first thermal cycle. Succeeding thermal cycles remain the same or thermally ratchet to more severe negative or inward pressure loadings. Components which survive the first thermal cycle can be crushed in later thermal cycles.

Recommendations

Two general recommendations for PSBF encapsulation of electronic assemblies can be made, based on the results of this study. The first is that 0.2 to 0.4 g/cm^3 PSBF may be safely used for all

except the most fragile electronic components, but that 0.5 to 0.6 g/cm^3 PSBF should be used with care because of crushing pressures which can develop. The second recommendation is that since PWB movement can occur during the fusion cycle, insulating spacers should be used to prevent electrical shorts and rigid PWB spacers should be used to prevent change in any critical electrical circuit operating parameters.

ACCOMPLISHMENTS

An experimental survey of several types of loads and deflections caused by encapsulation in 0.2, 0.3, 0.4, 0.5 and 0.6 g/cm^3 densities of PSBF has been made using a dummy electronic unit. The three lowest densities were found to be safe against thermomechanical stresses for all but the most fragile electronic components. The two highest densities must be used with more care. Also, adequate care must be exercised to prevent electrical shorts or change in electrical circuit operating parameters which can be caused by PWB movement during the PSBF fusion cycle.

FUTURE WORK

Work is already under way to determine failure criteria for microcircuits used in the production version of the dummy unit studied here. Other work in progress will collect experimental data on loads and deflections in such a production unit. Shock and vibration response also will be measured for that unit.

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BDX-613-2488

MULTI-TRANSDUCER DUMMY UNIT EVALUATION OF POLYSYTRENE BEAD FOAM AS AN ENCAPSULANT FOR ELECTRONIC PACKAGES, G. D. Swanson, September 1980

A dummy electronic assembly without electronic components was used to measure loadings and deflections caused by 0.2, 0.3, 0.4, 0.5 and 0.6 g/cm^3 densities of polystyrene bead foam during fusion and thermal cycling. Previously developed and proven transducers showed that the lower three densities caused low and safe loads and deflections, but that the highest two densities must be used with care for fragile electronic components.

ELECTRONICS: Encapsulation

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